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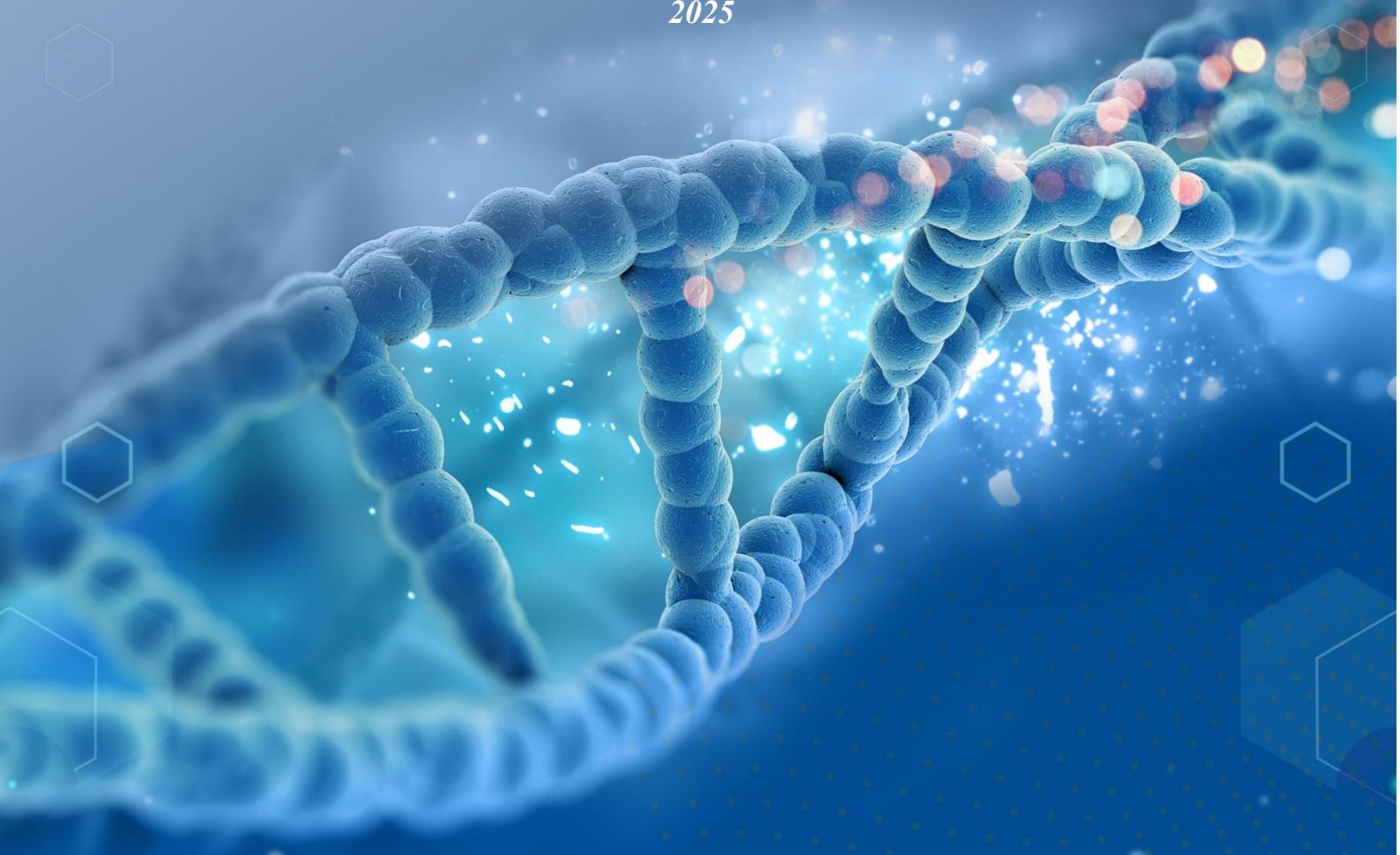

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Research Article

Determination of Diabetes Knowledge Level in Intensive Care Unit Nurses*

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*This research is derived from Neslihan Koyuncu's Master's thesis.

Abstract

Objective: The knowledge level of intensive care nurses, who are primarily responsible for follow-up and treatment in intensive care units, about general diabetes and insulin applications is significant for good glucose regulation. This study aimed to examine the knowledge levels of intensive care nurses about diabetes and the factors affecting them.

Method: The descriptive study was conducted with 328 (n=328) nurses between February 2021 and June 2021. Demographic questionnaires and the Diabetes Knowledge Test developed by the Michigan Diabetes Research and Education Center were administered after obtaining the voluntary consent of the participants. The data obtained were evaluated by applying Kruskal Wallis, Mann Withney U and Wilcoxon W tests in SPSS 25.0 program, and statistical significance was defined as $p < 0.05$.

Results: When the answers given to the questionnaires according to the demographic data of the nurses were compared, it was found that the most important factors affecting the level of diabetes knowledge were the level of education and the number of relatives with diabetes. In our study, the level of diabetes knowledge in intensive care nurses was 74.8%. However, no statistically significant difference was found between nurses with and without intensive care certificates and nurses with and without previous diabetes education.

Conclusion: In order to evaluate intensive care nurses, it is recommended that the content of diabetes education given in the in-service and intensive care certificate programs and the survey questions be reviewed, planned and implemented for intensive care services.

Keywords: Diabetes, Intensive Care, Knowledge, Nurse.

INTRODUCTION

Diabetes mellitus (DM) is a metabolic syndrome characterized by hyperglycemia. Defects in insulin metabolism lead to hyperglycemia and prolonged exposure to hyperglycemia can cause damage to tissues and organs (Abdullah et al., 2001). DM is the most common endocrine disorder in the general population and in intensive care unit patients (Durmaz, 2009). Today, diabetes is an increasingly important health problem all over the world due to its frequency and complications, and 9.3% of adults aged 20-79, approximately 463 million people, live with diabetes (Alotaibi et al., 2016; American Diabetes Association Professional Practice Committee, 2024; ElSayed et al., 2024). One point one million children and adolescents under the age of twenty are also living with Type 1 diabetes (American Diabetes Association Professional Practice Committee, 2024; ElSayed et al., 2024). The International Diabetes Federation (IDF) estimates that there will be 578 million adults with diabetes by 2030 and 700 million by 2045 (Anderson et al., 2000). The mortality and morbidity rates of diabetes are gradually increasing in the world and are frequently encountered in intensive care units due to its increasing prevalence and leading to complications in cases where monitoring and treatment are uncontrolled (Aydoğan, 2005; The NICE-SUGAR, 2015). In hospitalized individuals with DM, well-controlled blood glucose levels are very important in improving clinical symptoms, preventing and treating infections, reducing cardiac, cerebral and respiratory disorders and especially in ensuring wound healing. Therefore, the importance of the care and monitoring of individuals with DM in preoperative care units, postoperative intensive care units and general intensive care units is increasing day by day (Anderson et al., 2000; Bansal et al., 2018; Drass et al., 1989). It is extremely important that intensive care nurses, who closely observe intensive care patients, continuously follow the changes and developments in patients, identify problems in the early period and spend a long time with patients, can take an active and effective role in the blood glucose regulation of patients (Canbolat et al., 2019). Nurses have the responsibility to make decisions on issues such as chronic disease management, patient care and improving patient care from the first encounter with the patient in intensive care units (Canbolat & Kapucu, 2021). In order to ensure optimal blood glucose regulation in intensive care patients, in addition to appropriate treatment, follow-up of the individual with diabetes, correct administration of diabetes medications, complications and nutrition should be monitored. Therefore, the knowledge level of intensive care nurses regarding general diabetes and insulin applications has become more important with the increasing prevalence of diabetes (Chianca et al., 2012). Although the available evidence is limited, it is thought that appropriate blood glucose control may help prevent exacerbation of Covid-19 in patients with diabetes. Under the current circumstances, where there is no definitive cure for the disease, it is noted that the role of blood glucose control in recovery is important (Collins et al., 2011). Approximately 30-40% of patients admitted with Covid-19 infection have hyperglycemia and/or diabetes. Studies are being conducted on standard clinical practices and protocols and the effectiveness of devices to ensure that glucose control in intensive care is safe and effective and does not create a workload for nurses (Corrêa et al., 2012; Coursin et al., 2002). Appropriately trained health care teams can improve glycemic control and outcomes and shorten hospital stays (Arda

Dağdelen, 2012; Daly et al., 2014; Evans et al., 2021). Studies have shown that hospital readmission rates and costs can be reduced in patients who receive inpatient treatment by a team that can manage diabetes (Draznin et al., 2013; El-Deirawi & Zuraikat, 2001; Ergan et al., 2018). In a meta-analysis of studies in which education and standardized practices were organized to improve glucose control in the hospital, there was a decrease in the mean of blood glucose levels, no increase in hypoglycemia, and an increase in the time patients spent within the target range of blood glucose values (Fitzgerald et al., 2016). Glucose regulation is one of the important factors determining mortality and morbidity in patients with diabetes followed up in intensive care units. Therefore, in hospitalized intensive care patients, especially in intensive care patients who are frequently encountered with hyperglycemia and who need critical and continuous care, it is important to follow up and treat diabetes by nurses who are primarily responsible for patient follow-up.

The aim of this study was to determine the knowledge levels of intensive care nurses about diabetes and to examine the factors affecting their knowledge levels by accepting nurses working in intensive care units and nurses with previous experience of working in intensive care units as a sample.

METHOD

This descriptive study was conducted between February 2021 and June 2021 at Health Sciences University Tepecik Training and Research Hospital located in Konak district of Izmir province, after obtaining written permission from Izmir Health Sciences University Dr. Suat Seren Chest Diseases and Thoracic Surgery Training and Research Hospital and obtaining the voluntary consent of the nurses included in the study. Diabetes treatment of patients in secondary and tertiary intensive care units in these hospitals is planned by intensive care physicians, with internal medicine or endocrine consultation when necessary. Activities such as implementation of treatment, blood glucose monitoring, planning and monitoring of nutrition, diabetic medication management (cold chain, etc.), patient monitoring, follow-up of additional diseases, diabetic wound dressing are also carried out by intensive care nurses. A total of 1296 nurses work in these two hospitals and 328 nurses were reached. The reason for this was that our inclusion criteria required participants to be currently working in any intensive care unit or to have worked in intensive care for at least one year previously. Our exclusion criteria were working in intensive care unit for less than one year and not having worked in intensive care unit before. From a total of 366 nurses working at Dr. Suat Seren Chest Diseases and Thoracic Surgery Training and Research Hospital, we reached all 72 nurses currently working in intensive care units and 60 nurses currently working in different units who had previously worked in intensive care units. Out of a total of 930 nurses working in Tepecik Training and Research Hospital, 220 intensive care nurses working in intensive care units were tried to be reached and a total of 196 nurses voluntarily completed the questionnaire. According to the power analysis performed at the planning stage of the study, the sample size was determined to reach at least 250 nurses (n ≥250).

Data Collection Tools

Demographic Data Form and Diabetes Knowledge Test (DKT) were used as data collection tools.

Demographic Data Form: The demographic data form prepared by the researchers consisted of

16 questions, and open-ended answers were left for those who answered 'yes' to three questions. In this form, descriptive characteristics of the nurses are asked (age, gender, marital status, educational status, working time in the profession, professional status, the unit and duration of employment, the duration of employment in intensive care, whether or not they have an intensive care certificate, whether or not they have received diabetes education in the certificate program, evaluation of general diabetes knowledge, whether or not they have received diabetes education before, how often they encounter diabetics, whether they have diabetes in their family, and chronic disease status).

Diabetes Knowledge Test (DKT): The Diabetes Knowledge Test consists of 23 knowledge test items developed by the Michigan Diabetes Research Training Center (MDRC). The first 14 questions cover diet, metabolic testing, diabetes complications and exercise. The last nine questions are about insulin and insulin administration. The test takes approximately 15 minutes to complete. Each question has only one correct answer. Correct answers are awarded one point and incorrect and blank answers are awarded zero points. The scores obtained for each nurse were converted into percentages (Fitzgerald et al., 1998; Futatsugi et al., 2020). Permission to use the DKT was obtained from MDRC via e-mail and supported by the number P30DK020572.

Statistical Analysis

The data obtained were evaluated by applying Kruskal Wallis, Mann Withney U, Wilcoxon W tests by an expert in the field of biostatistics in SPSS 25.0 package program. Statistical significance was defined as $p<0.05$.

RESULTS

Our study was conducted with a total of 328 nurses, 206 female (79.2%) and 68 male (20.7%). The scores obtained by female nurses from the first 14 questions of the questionnaire (including diet, metabolic tests, diabetes complications and exercise) and the last nine questions (including insulin and insulin applications), that is, the level of diabetes knowledge, were higher than those obtained by male nurses. The difference in scores was found to be significant ($p<0.05$), and it was thought that this difference was due to the fact that the number of female nurses working in the general hospital environment and participating in the study was higher than the number of male nurses (Table 1). Of the nurses who participated in the study, 23 were high school graduates, 36 were associate degree graduates, 220 were bachelor's degree graduates, 44 were master's degree graduates and five were PhD graduates, and the number of bachelor's degree graduates constituted the highest level of knowledge was found in master's degree graduates with 44 people. The scores of high school, associate degree, bachelor's degree and master's degree graduates in all questions of the questionnaire were significantly and quite different ($p<0.05$) (Table 2).

The higher the degree of graduation, the higher the scores obtained and therefore the higher the level of diabetes knowledge. When we examined whether the nurses received diabetes education according to their educational status, 52.2% of high school graduates, 50% of associate's and bachelor's degree graduates, 38.6% of master's degree graduates and all doctoral graduates stated that they had received diabetes education before. In total, 49.4% of the participants stated that they had received DM education and 50.6% stated that they had not.

Table 1. Comparison of Diabetes knowledge level of nurses participating in the study according to gender (n=328)

Diabetes Knowledge Test	Female	Male	Test Statistic*	p
Metabolic Tests/Complications Exercise questions	**Mean±Std. Deviation**		-4,184	**<0,01**
	9,65±2,06	8,54±2,27		
	Median (Min-Max)			
	10 (0-13)	8(2-13)		
Insulin Applications Questions about the questions	**Mean± Std. Deviation**		-2,634	**0,008**
	7,06±1,7	6,33±2,09		
	Median (Min-Max)			
	7 (0-9)	7(1-9)		
Total Score	**Mean± Std. Deviation**		-3,648	**<0,01**
	16,7±3,3	16,33±3,5		
	Median (Min-Max)			
	17 (0-22)	17(0-22)		

*Mann Whitney-U/Wilcoxon W

Our inclusion criteria were that the nurses should be working in intensive care or have worked in intensive care for at least one year before. In this context, when we compared the scores of the nurses who participated in the study according to the units they were currently working in, it was seen that there was no significant difference in terms of diabetes knowledge level (p>0.05) (Table 3). One of the nurses had been working in their current units for 19 years and 76 of them had been working in their current units for one year, and when the working time in these clinics was evaluated, no significant difference was found in terms of diabetes knowledge level (p>0.05). Of the nurses who participated in our study, 114 (34.7%) had been working in intensive care for 1-5 years. No significant difference was found when the duration of employment in intensive care unit was compared with the level of diabetes knowledge (p>0.05) (Table 4).

Table 2. Comparison of Diabetes knowledge level according to the education level of the nurses participating in the study (n=328)

Level of Education	High School	Associate Degree	Bachelor's Degree	Master Degree	Doctoral Degree	Test Statistic*	p
Metabolic Tests Complication/ Exercise questions	**Mean±Std. Deviation**					21,665	**<0,01**
	7,26±3,1	8,88±3,0	9,59±1,7	10,11±1,9	9,60±0,8		
	Median (Min-Max)						
	7(0-12)	9,5(2-13)	10(4-13)	11(2-13)	10(8-10)		
Insulin Applications Questions about the questions	**Mean±Std. Deviation**					12,563	**0,014**
	5,39±2,5	6,44±2,2	7,13±1,5	6,93±1,8	7,60±0,8		
	Median (Min-Max)						
	5(0-9)	7(1-9)	7(1-9)	7(1-9)	8(6-8)		
Total Score	**Mean± Std. Deviation**						**<0,01**
	12,65±5,4	15,33±4,9	16,72±2,8	17,04±3,4	17,20±1,7		
	Median (Min-Max)						
	14(0-20)	16,5(3-22)	17(5-22)	18(3-21)	18(14-18)	17,966	

*Kruskal Wallis H

Table 3. Comparison of Diabetes knowledge levels of the nurses participating in the study according to the units they work (n=328)

Units	MetabolicTests Complication/ Exercise questions	Insulin Applications Questions about the questions	Total Score
	Mean±Std Deviation Median(Min-Max)		
Surgical wards	8,67±3,3 10(0-12)	6,64±2,8 8(0-9)	15,32±5,9 17,5(0-21)
Internal services	10,00±2,0 10(5-13)	7,48±1,2 7(4-9)	17,48±2,7 17(9-21)
Emergency Services	9,52±1,6 10(6-13)	6,72±1,5 7(3-9)	16,24±2,7 17(11-22)
ICU	9,38±2,0 10(2-13)	6,90±1,7 7(1-9)	16,29±3,3 17(3-22)
Polyclinic	8,75±3,0 10(4-12)	6,00±2,2 7(2-8)	14,75±5,1 17(6-19)
Operating Room	9,21±1,8 9,5(4-11)	6,42±2,0 6,5(1-9)	15,64±3,5 16(5-20)
Palliative care	10,12±1,1 10(9-12)	7,87±1,1 8(6-9)	18,00±2,0 18(15-21)
Education Unit	11,50±1,0 11(11-13)	6,50±1,7 7(4-8)	18,00±2,1 18,5(15-20)
Matron	9,50±0,7 9,5(9-10)	8,50±0,7 8,5(8-9)	18,00±0,0 18(18-18)
Test Statistic*	11,168	14,384	11,424
P	0,345	0,156	0,325

*Kruskal Wallis H

Similar results were obtained when the duration of working in intensive care unit and diabetes knowledge levels of nurses who had previously worked in intensive care units were compared. It is thought that the fact that intensive care units are mostly composed of new graduates and young individuals and that nurses cannot work in these units for many years due to the high workload in intensive care units and transfer to other units may be effective in the lack of difference. One of the most important hypotheses of our study was whether there was a difference between nurses with and without an intensive care certificate in terms of diabetes knowledge level. Of the nurses who participated in our study, 111 (33.8%) had an intensive care certificate and 217 (66.1%) did not. In our study, no significant difference was found between nurses with and without a certificate in terms of diabetes knowledge level ($p > 0.05$). When we examined the status of diabetes education in the certificate program of nurses with a certificate, it was found that 64% received diabetes education in the certificate program and 45.9% did not receive diabetes education in the certificate program. When we compared the results of the questionnaire according to the nurses' previous DM education, 49.3% of the nurses stated that they had received diabetes education before and 50.6% stated that they had not received diabetes education before. When we compared the scores of the nurses according to their DM training status, no statistically significant difference was found ($p>0.05$). Among the nurses who received

diabetes education, 76 of them received DM education once and five of them received DM education many times, but no significant difference was found between the number of education and diabetes knowledge level (p>0.05).

Table 4. Comparison of Diabetes knowledge levels of the nurses participating in the study according to the duration of working in Intensive Care Unit (n=328)

Intensive Care Unit Working Period	Metabolic Tests Complication/ Exercise questions	Insulin Applications Questions about the questions	Total Score
	Mean±Std. Deviation Median (Min-Max)		
1-5 year	9,32±1,9 9(2-13)	6,92±1,7 7(1-9)	16,25±3,1 17(3-22)
5-10 year	9,25±2,2 9(2-13)	6,67±2,0 7,5(1-9)	15,93±4,0 17(3-21)
10-20 year	9,66±1,6 10(4-12)	7,29±1,1 7(5-9)	16,96±2,2 17(11-20)
20 and above	1 kişi 9,00	1 kişi 6,00	1 kişi 15,00
I'm not working right now	9,54±2,3 10(0-13)	6,94±1,9 7(0-9)	16,49±3,9 17(0-22)
Test Statistic*	3,673	1,694	3,296
p	0,452	0,791	0,509

*Kruskal Wallis H

When we examined the status of receiving diabetes education in the certificate program of nurses with a certificate, it was found that 64% received diabetes education in the certificate program and 45.9% did not receive diabetes education in the certificate program. We asked the nurses to answer the frequency of encountering patients with diabetes. Thirty-nine point six percent of the nurses stated that they met with patients with diabetes every day, 34.1% met with them two to three times a week, 10.6% met with them once or twice a month and 15.5% rarely met with them. When we compared the scores of nurses according to the frequency of encountering patients with diabetes, no significant difference was found (p>0.05).

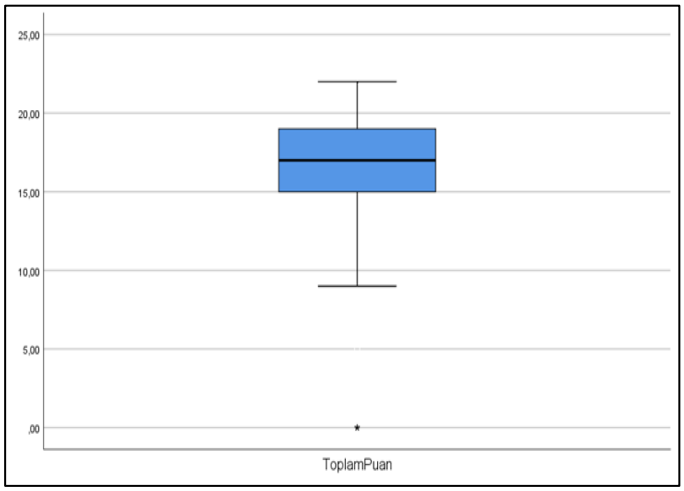
When we analyzed the nurses according to having a relative with diabetes, 42% had a relative with diabetes and 57.6% did not have a relative with diabetes. When the scores obtained from the questionnaire by nurses with and without relatives with diabetes were compared, the knowledge levels of those with relatives with diabetes in the first 14 questions were found to be significantly higher than those without (p< 0.05). There was no statistical difference (p>0.05) between the scores of the nurses who had a relative with diabetes and the scores of the nurses who did not have a relative with diabetes. In our study, when we examined

how many relatives with diabetes the nurses who had relatives with diabetes had; it was seen that 79 of them had one relative with diabetes and 47 of them had two relatives with diabetes. It was observed that the level of diabetes knowledge increased as the number of relatives with diabetes increased, and those with four or more relatives with diabetes had higher levels of diabetes knowledge ($p< 0.05$).

When the chronic disease status of the nurses was analyzed, it was found that 74 nurses (22.5%) had chronic disease and 253 nurses (77.1%) did not have chronic disease. When the questionnaire scores were evaluated according to chronic disease status, no statistically significant difference was found ($p>0.05$). When the participant nurses were evaluated according to the type of chronic disease, it was concluded that most of the nurses had thyroid disease (24.3%), 16.2% had diabetes and 76.8% did not have chronic diseases. When chronic disease status and questionnaire scores were analyzed, no statistically significant difference was found, and the presence of diabetes did not make a difference ($p>0.05$).

Most of the nurses who participated in our study (n=217) did not have an intensive care certificate. The reason for this is thought to be that nurses working in intensive care units have less time in intensive care units and that certificate programs and in-service diabetes trainings could not be organized due to the Covid-19 pandemic that has been going on for two years. It was also thought that there may not have been enough time to answer the survey questions effectively due to reasons such as the workload of the nurses, the fact that the hospitals where the study was conducted were very busy hospitals due to their location, being in the pandemic period.

As a result, the nurses who participated in our survey received a median score of 16 points from the questionnaire. Diabetes knowledge level was high with 74.8%, but it was not statistically significant (Graph 1).



Graph 1: Knowledge level of nurses according to the answers given to the survey questions (n=328)

DISCUSSION

Diabetes is one of the most common endocrine disorders in the general population and in intensive care unit patients. In hospitalized individuals with DM; well-controlled blood glucose levels are very important in improving clinical symptoms, preventing or treating infections, treating cardiac, cerebral, respiratory disorders and especially in ensuring wound healing. Therefore, the importance of the care and monitoring of individuals with DM in preoperative care units, postoperative intensive care units and general intensive care units is increasing day by day (American Diabetes Association, 2021; Modic et al., 2014; Olsen et al., 2012; Ostling et al., 2017).

It is extremely important that intensive care nurses, who closely observe intensive care patients, continuously monitor changes and developments in patients, recognize problems at an early stage and spend a long time with patients, can take an active and effective role in the glycemic follow-up of patients. Nurses have the responsibility to make decisions on issues such as chronic disease management, patient care and improving patient care from the first encounter with the patient in intensive care units. The overall management of all types of diabetes is related to multiple factors such as medication, diet and nutrition, blood glucose control, regular physical activity, and the presence/screening for long-term complications. In this decision-making role model, nurses should have the necessary diabetes knowledge to provide effective treatment and care (American Diabetes Association Professional Practice Committee, 2024; Canbolat & Kapucu, 2021; Modic et al., 2014).

Nursing professionals receive diabetes-related trainings in undergraduate education, after which they can obtain information about diabetes by receiving diabetes education in various certificate programs or in the form of in-service training in the institutions where they work. In some studies, it has been reported that nurses and doctors are the most effective people in increasing the knowledge level of patients with diabetes, and that nurses have a great effect on reducing the HbA1c level of patients and their compliance with the diet (Adam et al., 2003; Modic et al., 2014).

Different tests have been developed to determine the level of knowledge about diabetes and these tests have been used in different studies (Fitzgerald et al., 1998; Gupta & Hudson, 2017; Hall & Davies, 2008; Saeedi et al., 2020). In Turkey, no scales related to diabetes knowledge level were found in the diabetes scales search in the Turkish Measurement Tools Directory (TOAD) (Magliano et al., 2021). In our literature review, some studies and articles were found in which the diabetes knowledge test we used in our study was used, and it was seen that this test was generally used in our country to examine the level of diabetes knowledge in patients, clinical nurses and student groups (İdiz et al, 2020; Khalaila et al., 2011; Kim & Oh, 2003; Leggett-Frazier et al., 1994; Livingston & Dunning, 2010; Modic et al., 2009). There are no studies in Turkey in which diabetes knowledge level test was used to evaluate the diabetes knowledge level of intensive care nurses. Therefore, our study constitutes a first.

After the Diabetes Knowledge Level Test was validated and published in 1998, it was revised and re-published by Fitzgerald et al. in 2016 (Nash, 2009). In most of the studies conducted with patients with diabetes, factors such as age, gender, education level, duration of diabetes treatment and depression levels of patients were found to be effective on diabetes knowledge level (Olsen et al., 2012). In studies

conducted with nurses, the frequency of encountering patients with diabetes in the units where nurses work, in-service trainings about diabetes and access to educational resources were found to be important factors (Ostling et al., 2017). In our study, the level of diabetes knowledge of nurses did not create a significant difference according to the units they worked in and the status of receiving diabetes education. Oyetunde et al. (2014) found that the mean scores of intensive care nurses were significantly higher than those of internal medicine, surgery and gynecology clinics. In another study, it was stated that working time was found to be a factor affecting the knowledge level of nurses, and it was reported that diabetes knowledge was lower in those with less working time (Patterson et al., 2019).

While the development process of nursing continued, certified training programs for specialization began to be organized and in this context, intensive care certificate programs were established for intensive care nurses. The aim of the Intensive Care Nursing Certified Training Program in our country is to train intensive care nurses who provide physical, psychological and social empowerment of the individual with preventive, developmental and rehabilitative interventions, establish therapeutic communication with patients and their families, adapt to developments in health science and technology, new treatment and care methods, have the competence to meet emergency, critical and complex patient care needs, and have advanced problem-solving skills. In this training program, which lasts an average of four to five weeks, both theoretical and practical trainings are given, and at the end of the training period, a written exam is held and the successful participants are given certificates approved by the Ministry of Health. In our study, we investigated the diabetes education status of intensive care nurses, whether they had an intensive care certificate and their level of diabetes knowledge according to their certificate status. One hundred and eleven of the nurses participating in our study had an intensive care certificate, while 217 did not have a certificate. When we examined the status of receiving diabetes education in the certificate program of nurses with a certificate, it was found that 64% received diabetes education in the certificate program and 45.9% did not receive diabetes education in the certificate program. There was no significant difference between nurses with a certificate and nurses without a certificate in terms of diabetes knowledge level ($p>0.05$). Although in different countries, many studies have found low rates of individual participation in diabetes-related trainings among nurses. The age of nurses, excessive workload and working conditions have been identified as barriers that affect nurses' acquisition of diabetes knowledge (Ostling et al., 2017). In a literature review conducted by Alotaibi et al. (2016) from 2004 to 2014 on the level of diabetes knowledge of nurses, studies investigating the knowledge level of nurses using the Diabetes Basic Knowledge Tool (DBKT) and the Diabetes Self-Report Tool (DSRT) were examined and it was concluded that 34% of nurses did not have sufficient knowledge about OADs (Scheiderich et al., 1983). Twelve articles from the USA, UK and Jordan were reviewed and in ten studies, nurses' knowledge of insulin therapy, including injection administration time and storage conditions, was found to be low (48%). It was concluded that 34% of nurses did not know the correct storage conditions of insulin (Oyetunde & Famakinwa, 2014; Patterson et al., 2019; Scheiderich et al., 1983). In a study conducted in the United Kingdom, it was found that 72% of pediatric nurses working with specialist doctors had a low level of knowledge about insulin administration time

and storage (Thomas, 2004). Three studies conducted in the UK, Nigeria and Hong Kong revealed that nurses have insufficient knowledge about general diabetes knowledge, foot care and wound care in diabetes (Shiu & Wong, 2011; Soysal, 2019; Sucu et al., 2012). Inadequate knowledge about diabetes complications can be serious for patients. Complications such as lower extremity amputations, cardiovascular disease, nephropathy, retinopathy, hypoglycemia, ketoacidosis cause serious consequences in these patients. Studies conducted in different countries have revealed that nurses have insufficient knowledge about diabetes complications (Soysal, 2019; Toraman, 2019). In the studies conducted by Modic et al. (2009) and Modic et al. (2014), it was concluded that experienced cardiovascular nurses in intensive care centers had less knowledge about insulin therapy. A study conducted in the UK concluded that more than 54% of pediatric nurses were not aware of the possible side effects of repeated insulin injections (Thomas, 2004). The common conclusion of these studies was that nurses in many countries lack knowledge in at least some aspects of insulin therapy and that this lack of knowledge can significantly affect their ability to effectively manage diabetes.

In the literature review conducted by Alotaibi et al. (2016), nine studies were identified in which nurses' knowledge of diabetes pathology and symptoms were evaluated and the level of diabetes knowledge was found to be low in these studies. In a study conducted in the USA (Scheiderich et al., 1983), 26% of acute care nurses did not have knowledge about the genetic aspects of Type 1 diabetes, and in Nigeria, 50.9% of nurses did not know any signs of diabetes or symptoms of diabetes ketoacidosis, and only 12% were able to recognize all symptoms (Valk & McMorrow, 2020). Nutrition is one of the most important content areas of diabetes care. In the literature review conducted by Alotaibi et al. (2016), seven of 12 studies evaluated nurses' knowledge of nutrition in diabetes and reported that the level of knowledge was insufficient. In two studies conducted in Sweden, it was concluded that nurses lacked knowledge about diabetes types (Olsen et al., 2012). In general, research results show that there is a lack of knowledge about the pathology, symptoms and management of diabetes among nurses in many countries. The literature review by Alotaibi et al. (2016) found that barriers to acquiring knowledge about good practices, care and development in diabetes were commonly reported across participants. Alotaibi et al. (2016), who stated that some strategies managed to significantly improve nurses' diabetes knowledge and attitudes, stated that organizing a formal education program every three months with multidisciplinary expert diabetes teams (e.g. doctors, pharmacists, nurses and diabetes educators) and sharing updates about diabetes is beneficial for nurses and their patients. In our study, as in the study of Oyetunde et al. (2014), it was observed that the scores of those with relatives with diabetes were higher than those without relatives with diabetes. As the number of relatives with diabetes increased, the level of knowledge increased significantly ($p<0.05$). The fact that there was no difference between professional experience, i.e. working time, and diabetes knowledge level in our study is supported by the study of Oyetunde et al. (2014).

CONCLUSION

In our questionnaire in which we evaluated the level of diabetes knowledge in intensive care nurses in many aspects, although the level of knowledge was above average, working in intensive care and having an intensive care

certificate did not statistically make a difference in terms of the level of knowledge. This situation is thought to be due to the fact that the hospitals where the study was conducted were very busy hospitals due to their location, the workload of the intensive care nurses participating in our study, the fact that they could not find enough time to answer the survey questions effectively due to reasons such as being in the pandemic period, and the lack of distinctive questions about diabetes practices in intensive care within the survey questions.

The most important factor affecting the level of diabetes knowledge in intensive care nurses is education. In order to provide standard care for patients with diabetes in intensive care units, it is recommended that in-service training on diabetes practices in intensive care units be provided, trainings be increased and these trainings be provided by diabetes education nurses who are experts in their field, protocols for the care of patients with diabetes in intensive care units of each institution be established and these protocols be implemented by nurses working in intensive care units, the content of diabetes education in intensive care certificate programs be reviewed and provided in accordance with intensive care standards. In order to evaluate the level of diabetes knowledge of intensive care nurses, it is recommended that the current questionnaire be developed for intensive care practices.

Limitations of the Study

The data of this study can be generalized only to the institutions where the study was conducted, since the study was conducted with nurses who worked or had worked in intensive care units in two training and research hospitals located in Konak district of Izmir province between the dates of the study and whose permissions were obtained, who met the inclusion criteria and volunteered.

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Ethical Approval: This study was approved by the Izmir Kâtip Çelebi University Non-Interventional Clinical Research Ethics Committee (Date: 18.02.2021) and (Decision no: 0036) and was conducted in accordance with the ethical rules in the Declaration of Helsinki**.**

References

Abdullah, L., Margolis, S., & Townsend, T. (2001). Primary health care patients' knowledge about diabetes in the United Arab Emirates. *Eastern Mediterranean Health Journal = La Revue De Sante De La Mediterranee Orientale = Al-Majallah Al-Sihhiyah Li-Sharq Al-Mutawassit*, *7*(4–5), 662–670.

Adam, K. D., Wendel, C. S., Solvas, P. A., Hoffman, R. M., Duckworth, W. C., Murata, G. H., Shah, J. H., & Bokhari, S. U. (2003). Factors affecting diabetes knowledge in Type 2 diabetic veterans. *Diabetologia*, *46*(8), 1170–1178.

Alotaibi, A., Al-Ganmi, A., Gholizadeh, L., & Perry, L. (2016). Diabetes knowledge of nurses in different countries: An integrative review. *Nurse Education Today*, *39*, 32–49.

American Diabetes Association. (2021). 1. Improving Care and Promoting Health in Populations: Standards of Medical Care in Diabetes—2021. *Diabetes Care*, *44*(Supplement 1), S7–S14.

American Diabetes Association Professional Practice Committee, ElSayed, N. A., Aleppo, G., Bannuru, R. R., Bruemmer, D., Collins, B. S., Ekhlaspour, L., Galindo, R. J., Hilliard, M. E., Johnson, E. L., Khunti, K., Lingvay, I., Matfin, G., McCoy, R. G., Perry, M. L., Pilla, S. J., Polsky, S., Prahalad, P., Pratley, R. E., … Gabbay, R. A. (2024). Diabetes Care in the Hospital: Standards of Care in Diabetes—2024. *Diabetes Care*, *47*(Supplement_1), S295–S306.

Anderson, R. M., Funnell, M. M., Fitzgerald, J. T., & Marrero, D. G. (2000). The Diabetes Empowerment Scale: A measure of psychosocial self-efficacy. *Diabetes Care*, *23*(6), 739–743. https://doi.org/10.2337/diacare.23.6.739

Arda Dağdelen, Z. (2012). *Aydın merkezde diyabet bilinci: Diyabetle ilgili bilgi düzeyi ve ilişkili faktörler*, Tıpta Uzmanlık Tezi, Adnan Menderes Üniversitesi.

Aydoğan, A. (2005). *Hemşirelerin Diyabet İle İlgili Bilgi Düzeylerinin Tespiti,* Yüksek Lisans Tezi, Afyon Kocatepe Üniversitesi.

Bansal, V., Mottalib, A., Pawar, T. K., Abbasakoor, N., Chuang, E., Chaudhry, A., Sakr, M., Gabbay, R. A., & Hamdy, O. (2018). Inpatient diabetes management by specialized diabetes team versus primary service team in non-critical care units: Impact on 30-day readmission rate and hospital cost. *BMJ Open Diabetes Research & Care*, *6*(1), e000460.

Canbolat, Ö., & Kapucu, S. (2021). The Effect of Computer-Assisted Glycemic Monitoring Protocol on Workload of Intensive Care Nurses. *Hacettepe Üniversitesi Hemşirelik Fakültesi Dergisi*, *8*(3), 293–298.

Canbolat, O., Kapucu, S., & Kilickaya, O. (2019). Comparison of Routine and Computer-Guided Glucose Management for Glycemic Control in Critically Ill Patients. *Critical Care Nurse*, *39*(4), 20–27.

Chianca, T. C. M., Lima, A. P. S., & Salgado, P. D. O. (2012). Diagnósticos de enfermagem identificados em pacientes internados em Unidade de Terapia Intensiva Adulto. *Revista Da Escola de Enfermagem Da USP*, *46*(5), 1102–1108.

Collins, G. S., Mughal, S., Barnett, A. H., Fitzgerald, J., & Lloyd, C. E. (2011). Modification and validation of the Revised Diabetes Knowledge Scale. *Diabetic Medicine*, *28*(3), 306–310.

Corrêa, T. D., Almeida, F. P. D., Cavalcanti, A. B., Pereira, A. J., & Silva, E. (2012). Avaliação da percepção de enfermeiros sobre três protocolos para controle glicêmico em pacientes críticos. *Einstein (São Paulo)*, *10*(3), 347–353.

Coursin, D. B., Coursin, D. B., & Unger, B. (2002). Endocrine complications in intensive care unit patients. *Seminars in Anesthesia, Perioperative Medicine and Pain*, *21*(1), 59–74.

Daly, B., Arroll, B., Sheridan, N., Kenealy, T., & Scragg, R. (2014). Diabetes knowledge of nurses providing community care for diabetes patients in Auckland, New Zealand. *Primary Care Diabetes*, *8*(3), 215–223.

Drass, J. A., Muir-Nash, J., Boykin, P. C., Turek, J. M., & Baker, K. L. (1989). Perceived and Actual Level of Knowledge of Diabetes Mellitus Among Nurses. *Diabetes Care*, *12*(5), 351–356.

Draznin, B., Gilden, J., Golden, S. H., Inzucchi, S. E., & for the PRIDE investigators. (2013). Pathways to Quality Inpatient Management of Hyperglycemia and Diabetes: A Call to Action. *Diabetes Care*, *36*(7), 1807–1814.

El-Deirawi, K. M., & Zuraikat, N. (2001). Registered nurses' actual and perceived knowledge of diabetes mellitus. *Journal of Vascular Nursing*, *19*(3), 95–100.

Ergan, M., Başkurt, F., & Başkurt, Z. (2018). *Fizyoterapi Öğrencilerinin Diyabet ve Risk Faktörleri Bilgi Düzeylerinin Belirlenmesi*. *31*, 1–7.

Evans, L., Rhodes, A., Alhazzani, W., Antonelli, M., Coopersmith, C. M., French, C., Machado, F. R., Mcintyre, L., Ostermann, M., Prescott, H. C., Schorr, C., Simpson, S., Wiersinga, W. J., Alshamsi, F., Angus, D. C., Arabi, Y., Azevedo, L., Beale, R., Beilman, G., … Levy, M. (2021). Surviving sepsis campaign: International guidelines for management of sepsis and septic shock 2021. *Intensive Care Medicine*, *47*(11), 1181–1247.

Fitzgerald, J. T., Funnell, M. M., Anderson, R. M., Nwankwo, R., Stansfield, R. B., & Piatt, G. A. (2016). Validation of the Revised Brief Diabetes Knowledge Test (DKT2). *The Diabetes Educator*, *42*(2), 178–187.

Fitzgerald, J. T., Funnell, M. M., Hess, G. E., Barr, P. A., Anderson, R. M., Hiss, R. G., & Davis, W. K. (1998). The Reliability and Validity of a Brief Diabetes Knowledge Test. *Diabetes Care*, *21*(5), 706–710.

Futatsugi, H., Iwabu, M., Okada-Iwabu, M., Okamoto, K., Amano, Y., Morizaki, Y., Kadowaki, T., & Yamauchi, T. (2020). Blood Glucose Control Strategy for Type 2 Diabetes

Patients With COVID-19. *Frontiers in Cardiovascular Medicine*, *7*, 593061.

Gupta, T., & Hudson, M. (2017). Update on Glucose Management Among Noncritically Ill Patients Hospitalized on Medical and Surgical Wards. *Journal of the Endocrine Society*, *1*(4), 247–259.

Hall, A. P., & Davies, M. J. (2008). Diabetic emergencies in acute/critical care. *The Foundation Years*, *4*(6), 230–233.

İdiz, C., Çelik, S., Bağdemir, E., Dişsiz, M., & Satman, İ. (2020). Turkish Adaptation of Michigan Diabetes Research and Training Center's Revised Diabetes Knowledge Test and Determination of Factors Affecting the Knowledge Level of Diabetic Individuals. *The Turkish Journal of Endocrinology and Metabolism*, *24*(1), 38–46.

Khalaila, R., Libersky, E., Catz, D., Pomerantsev, E., Bayya, A., Linton, D. M., & Sviri, S. (2011). Nurse-Led Implementation of a Safe and Effective Intravenous Insulin Protocol in a Medical Intensive Care Unit. *Critical Care Nurse*, *31*(6), 27–35.

Kim, H., & Oh, J. (2003). Adherence to diabetes control recommendations: Impact of nurse telephone calls. *Journal of Advanced Nursing*, *44*(3), 256–261.

Leggett-Frazier, N., Turner, M. S., & Vincent, Paulinea. (1994). Measuring the Diabetes Knowledge of Nurses in Long-Term Care Facilities. *The Diabetes Educator*, *20*(4), 307–310.

Livingston, R., & Dunning, T. (2010). Practice nurses' role and knowledge about diabetes management within rural and remote Australian general practices. *European Diabetes Nursing*, *7*(2), 55–62.

Magliano, D. J., Boyko, E. J., & IDF Diabetes Atlas 10th edition scientific committee. (2021). *IDF Diabetes Atlas* (10th ed.). International Diabetes Federation.

Modic, M. B., Albert, N. M., Nutter, B., Coughlin, R., Murray, T., Spence, J., & Brosovich, D. (2009). Diabetes Teaching Is Not for the Faint of Heart: Are Cardiac Nurses Up to the Challenge? *Journal of Cardiovascular Nursing*, *24*(6), 439–446.

Modic, M. B., Vanderbilt, A., Siedlecki, S. L., Sauvey, R., Kaser, N., & Yager, C. (2014). Diabetes management unawareness: What do bedside nurses know? *Applied Nursing Research*, *27*(3), 157–161.

Nash, M. (2009). Mental health nurses' diabetes care skills – a training needs analysis. *British Journal of Nursing*, *18*(10), 626–630.

Olsen, M., Granath, A., Wharén, P., Blom, T., & Leksell, J. (2012). Perceived knowledge about diabetes among personnel in municipal care: A qualitative focus group interview study. *European Diabetes Nursing*, *9*(2), 52–55.

Ostling, S., Wyckoff, J., Ciarkowski, S. L., Pai, C.-W., Choe, H. M., Bahl, V., & Gianchandani, R. (2017). The relationship between diabetes mellitus and 30-day readmission rates. *Clinical Diabetes and Endocrinology*, *3*,3.

Oyetunde, M. O., & Famakinwa, T. T. (2014). Nurses' knowledge of contents of diabetes patient education in Ondo – state, Nigeria. *Journal of Nursing Education and Practice*, *4*(4), p91.

Patterson, C. C., Karuranga, S., Salpea, P., Saeedi, P., Dahlquist, G., Soltesz, G., & Ogle, G. D. (2019). Worldwide estimates of incidence, prevalence and mortality of type 1 diabetes in children and adolescents: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. *Diabetes Research and Clinical Practice*, *157*, 107842.

Saeedi, P., Salpea, P., Karuranga, S., Petersohn, I., Malanda, B., Gregg, E. W., Unwin, N., Wild, S. H., & Williams, R. (2020). Mortality attributable to diabetes in 20–79 years old adults, 2019 estimates: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. *Diabetes Research and Clinical Practice*, *162*, 108086.

Scheiderich, S. D., FreiBaum, C. N., & Peterson, L. M. (1983). Registered Nurses' Knowledge About Diabetes Mellitus. *Diabetes Care*, *6*(1), 57–61.

Shiu, A. T., & Wong, R. Y. (2011). Diabetes foot care knowledge: A survey of registered nurses. *Journal of Clinical Nursing*, *20*(15–16), 2367–2370.

Soysal, A. (2019). *Tip 2 diyabetli hastalarda diyabet bilgi düzeyi, sağlık okuryazarlığı ve diyabet öz yönetiminin glisemik kontrole etkisinin değerlendirilmesi*, Tıpta Uzmanlık Tezi, Eskişehir Osmangazi Üniversitesi.

Sucu, G., Dicle, A., & Saka, O. (2012). *Decision Making in Clinical Nursing: Decision-Making Models and Affecting Factors*. *9*(1), 52–60.

The NICE-SUGAR Study Investigators for the Australian and New Zealand Intensive Care Society Clinical Trials Group and the Canadian Critical Care Trials Group. (2015). Intensive versus conventional glucose control in critically ill patients with traumatic brain injury: Long-term follow-up of a subgroup of patients from the NICE-SUGAR study. *Intensive Care Medicine*, *41*(6), 1037–1047.

Thomas, E. (2004). *Survey reveals shortfall in paediatric nurses' knowledge of diabetes. 8*(6), 217–221.

Toraman, K. (2019). *İç hastalıkları kliniklerinde çalışan hemşirelerin diyabet farkındalığı ve diyabetli hastalara yaklaşımlarının incelenmesi*, Yüksek Lisans Tezi, Sakarya Üniversitesi.

Valk, T., & McMorrow, C. (2020). Managing hyperglycemia during the COVID-19 pandemic: Improving outcomes using new technologies in intensive care. *SAGE Open Medicine*, *8*, 2050312120974174.

NORTHERN JOURNAL of HEALTH SCIENCES

Research Article

Antioxidant Role of Beta-glucan on Cisplatin-induced Liver Injury in Rats

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Abstract

Objective: Cisplatin (cisdiamminedichloridoplatinum II [CDDP]) is an antineoplastic cancer drug frequently used in the treatment of a wide variety of cancers. In addition to its positive effects, it may have toxic effects in tissues such as hepatoxicity. In this study, we investigated the reparative effects of beta-glucan, a potent antioxidant, on cisplatin-induced hepatoxicity.

Method: In this study, 40 Wistar Albino rats were randomly divided into 2 groups according to the time of sacrifice, 3rd day and 5th day (n=20 in each group). Each group was divided into four groups as control, Beta-glucan (100 mg/kg/bw), cisplatin (10 mg/kg/bw), cisplatin+beta-glucan (n=5 in each group). The rats were sacrificed 3 days and 5 days after the last injections and liver tissue samples were taken for routine tissue follow-up for histopathologic examination under light microscope. Paraffin blocks were sectioned and stained with Hemaoxylin-Eosin.

Results: Histopathological examination revealed different degrees of hydropic degeneration, sinusoidal expansion, disorganization of hepatic cords, inflammatory cell foci and changes in the density of Kupffer cells in cisplatin 3rd day and cisplatin 5th day groups compared to the control group. When cisplatin was administered together with beta-glucan, cell damage was found to be minimal in cisplatin+beta-glucan 3rd and cisplatin+beta-glucan 5th day groups.

Conclusion: Light microscopic findings suggest that beta-glucan may have protective effects on cisplatin-induced liver injury.

Keywords: Antioxidant, Beta-glucan, Cisplatin, Liver Injury.

INTRODUCTION

Cisplatin (cisdiamminedichloridoplatinum II [CDDP]) is a platinum-derived antineoplastic agent (Güleç et al., 2004) used in the treatment of many solid tumors such as head, neck, ovarian, bladder, breast, lung and cervical cancers (Abdel-Daim et al., 2020). Cisplatin, like many other chemotherapeutic agents, does not discriminate whether the cell is cancerous or non-cancerous while exerting its antineoplastic effect, and therefore many side effects have been recorded in chemotherapeutic treatment (El-Hak et al., 2022). The most important dose-limiting side effect in the clinic is nephrotoxicity (Fouad et al., 2008). Another toxicity is dose-dependent hepatotoxicity due to accumulation in the liver during metabolism (Al-Majed, 2007; Mansour, 2006).

The liver is one of the organs involved in the metabolism of drugs. Hepatic blood flow and the capacity of the enzyme system play an important role in the metabolism of drugs by the liver. Many drugs such as cisplatin are biotransformed in the liver by the use of cytochrome P450 enzyme complex. Toxic metabolites of drugs may be released during biotransformation by the use of this enzyme complex (Kesim, 2001). Cisplatin rapidly diffuses into various tissues after injection and reaches higher concentrations in the liver. Cisplatin enters the cell via passive transport and hepatic metabolism is mediated by the enzyme cytochrome P450 2E1 (CYP2E1). Several studies have shown that the enzyme P450 2E1 (CYP2E1) may play a role in hepatotoxicity (Rashid et al., 2021). Cisplatin stops the cell cycle in G2 phase by forming deoxyribo nucleic acid (DNA) adducts and shows antineoplastic mechanism of action by triggering apoptosis. Although there is insufficient information about the hepatoxicity caused by cisplatin, it is thought that DNA adducts are the cause of this condition. Severel studies have shown that oxidative stress plays an important role in cisplatin hepatoxicity (Topcu Tarladaçalışır et al., 2005). Cisplatin decreases the level of antioxidant enzymes, leading to the accumulation of reactive oxygen species (ROS) in cells and the formation of oxidative stress, leading to toxic cell damage, heart diseases and many pathogenic diseases (Ekinci-Akdemir et al., 2020). Cisplatin damages mitochondrial protein by targeting it. This inhibits calcium uptake and decreases the potential of the mitochondrial membrane, triggering lipid peroxidation and apoptosis (El-Hak et al., 2022).

Therefore, various antioxidants such as vitamin E, selenium, vitamin C, glutamine, caffeic acid ester (CAPE), aminoguanidine and erdostein were used together to reduce the toxic effects of cisplatin treatment (Söğüt et al., 2004; Yılmaz et al., 2004). β-glucan (β-glucan) is a polysaccharide that forms the structural component of the cell walls of yeast, bacteria, fungi and cereals such as oats and barley. Since β-glucans differ structurally according to the source, their mechanism of action may also be different. Among these polysaccharides, the one obtained from baker's yeast (Saccharomyces cerevisia) is the type with high biological effects on which many studies have been conducted (Şener et al., 2007). β-glucan is a powerful antioxidant and immunomodulator (Akaras et al., 2019). The biological activities of beta-glucan are to regenerate damaged tissue and modulate inflammation (Gardiner, 2000). β-glucans protect DNA against oxidative damage with its free radical scavenging effect. Many studies have shown that it has beneficial effects against various diseases and disorders such as spinal cord injury, sepsis, post-menopausal brain injury, periodontal diseases, respiratory problems, ischaemia/reperfusion induced lung injury (Kaya et al., 2019). β-glucan exerts its effect on the immune system by binding to

special glucan receptors in monocytes, leukocytes and macrophages, releasing cytokinins and creating an immune response (Tatlı Seven et al., 2021), thus defending against bacteria, viruses, fungi and parasites, as well as preventing tumor development and showing protective effects against radiation (Şener et al., 2007).

In the light of this information, we aimed to reveal the protective effects of β-glucan, a potent antioxidant, against cisplatin-induced cell damage in the liver histopathologically.

METHOD

The injectable form of cisplatin (50 mg/50 ml) was purchased from Mayne Pharma Plc (Warwickshire, United Kingdom) and β-glucan (50 mg capsule Imuneks®) was obtained from Mustafa Nevzat Pharmaceutical Company (Turkey). All other chemicals were purchased from Sigma-Aldrich Chemical Company (St. Louis, MO, USA).

Wistar albino rats used in this study were obtained from Samsun Ondokuz Mayıs University Experimental Animals Research and Application Center. Six-eight week-old male Wistar albino rats of the same generation, weighing 200-300 g, were housed in plastic cages and fed standard chow and given unlimited water. The rats were kept in a controlled environment with a room temperature of 20-250 C and a 12-hour light/dark cycle.

The study was conducted with the approval of the ethics committee obtained from Ondokuz Mayıs University Samsun Clinical Research Ethics Committee (2009/83).

Experimental Design

Forty Wistar albino rats were randomly divided into two groups as 3rd day (n:20) and 5th day (n:20) according to the time of sacrifice. Both groups were divided into 4 subgroups with 5 rats in each group: Control, cisplatin, β-glucan, cisplatin+β-glucan. Control groups did not receive any injection. Cisplatin (10 mg/kg/bw) (Palipoch and Punsawad, 2013) was administered intraperitoneally (i.p.) as a single dose on the first day of the study. β-glucan (100 mg/kg/bw) (Tohamy et al., 2003) was administered intraperitoneally (i.p.) to β-glucan groups and cisplatin+β-glucan groups every day until the last day of the study. On the 3rd and 5th days, one day after the last injections in the groups, the rats were deeply anesthetized by intramuscular administration of a mixture of ketamine (40 mg/kg/bw) and xylazine (10 mg/kg/bw). The removed liver tissues were fixed in 10% neutral-buffered formalin for 48 hours. Samples were embedded in paraffin blocks after routine tissue tracking procedure. Then, 5µm thick sections were taken from the paraffin blocks with a microtome (Leica RM 2135; Nussloch, Germany). The sections were stained with Hematoxylin-Eosin (Mansouret et al., 2006) for light microscopic examination (Leica DM 1000). The sections were photographed using a digital camera (Leica DFC 290).

Histological Assessment

In the histological evaluation of the liver tissue, hydropic degeneration, sinusoidal expansion, disorganization of hepatic cords, inflammatory cell foci and Kupffer cells were observed in all groups. Accordingly, liver injury was evaluated using semiquantitative scale. The scores given for the damaged tissue in the semiquantitative scale were determined as follows: 0, normal; 1 (minimal), <25%; 2 (mild), <50%; 3 (moderate), <75%; 4 (severe), >75% of damaged area. Under light microscopy at 40x magnification, 10 areas of each group were examined and scored. The scoring of the sections was done blindly. The scores were then averaged and evaluated (Hamad et al. 2015).

Statistical Analysis

All statistical analyses were conducted by using SPSS 21.0 program. Non-parametric tests The Mann-Whitney U and Wilcoxon Rank Sum were used for the comparison of groups and $p<0.05$ was considered as statistically significant.

RESULTS

Light microscopic evaluation of the control and β-glucan groups revealed normal histologic appearance of the liver tissue (Figure 1 A, B). Hepatocytes were large polygonal shaped, nuclei were located in the center of the cell with single or sometimes double nuclei. Hepatocytes were arranged in a regular lobule structure with radial and radial arrangement around the central vein (V. centrolobularis). The branches of the portal vein (V. porta) and hepatic artery (A. hepatica) and the gallbladder ducts were normal.

Light microscopic evaluation of the cisplatin treated groups revealed significant cell damage in the liver tissue in both day groups. Sinusoidal expansion, hydropic degeneration in hepatocytes, disorganization in hepatic cords, inflammation foci and Kupffer cell activation were evaluated as cell damage markers. Both cisplatin groups showed remarkable histopathologic changes in general appearance compared to the control group (Figure 1 C, D). In the cisplatin 3rd day group, mild hydropic degeneration was observed in hepatocytes, especially around the central vein and portal area, as well as enlargement of sinusoids, disorganization of hepatic cords, inflammation foci and increase in Kupffer cells. In the cisplatin 5th day group, hydropic degeneration in hepatocytes was found to spread throughout the whole liver tissue and this was found to be more moderate compared to the 3rd day group (Table 1).

Table 1. Cell damage scores of cisplatin treated groups

Data	n	Control	3rd day	5th day
Hydropic degenerasyon	5	0	3	3
Sinuzoidal expansion	5	0	2	3
Disorganization of hepatic cords	5	0	2	3
Inflammatory cell foci	5	0	2	3
Kupffer cells	5	0	2	3

0, normal; 1 (minimal), <25%; 2 (mild), <50%; 3 (moderate), <75%; 4 (severe), >75% of damaged area.

Expansion of sinusoids, disorganization of hepatic cords, increase in the distribution of inflammation foci and increase in Kupffer cells were detected. When 3rd day and 5th day groups treated with cisplatin were compared with each other, no statistically significant changes were found in terms of hydropic degeneration and sinusoidal expansion ($p>0.05$; $p=0.650$; $p=0.142$, respectively), but statistically significant differences were found in terms of disorganisation of hepatic cords, inflammatory cell foci and Kupffer cells ($p<0.05$; $p=0.042$; $p=0.005$; $p=0.042$, respectively) (Table 2).

In the examination performed in the cisplatin+β-glucan 3rd day group, it was determined that the histological damage observed in the cisplatin 3rd day group decreased and decreased to a minimal level (Table 3).

Table 2. Statistical comparison of cisplatin 3rd day 5th day groups

Data	n	3rd day Mean rank	5th day Mean rank	p
Hydropic degenerasyon	5	5,10	5,90	0,650
Sinuzoidal expansion	5	4,20	6,80	0,142
Disorganization of hepatic cords	5	3,80	7,20	**0,042***
Inflammatory cell foci	5	3,00	8,00	**0,005***
Kupffer cells	5	3,80	7,20	**0,042***

p=significance level; If p<0.05 is significant between groups.

In the cisplatin+β-glucan 5th day group, it was determined that the damage decreased even more than the cislatin 5th day group and decreased to a minimal level (Figure 1 E-F). This shows that β-glucan played a more effective role in this group. β-glucan can reduce tissue damage when applied for a longer period of time.

Table 3. Cell damage scores of cisplatin+β-glucan treated groups

Data	Control	3rd day	5th day
Hydropic hepatosit degenerasyon	0	1	1
Sinuzoidal congestion	0	1	1
Disorganization of hepatic cords	0	1	1
Inflammatory cell foci	0	1	1
Kupffer cells	0	1	1

0, normal; 1 (minimal), <25%; 2 (mild), <50%; 3 (moderate), <75%; 4 (severe), >75% of damaged area.

When 3rd day and 5th day groups treated with cisplatin and β-glucan were compared with each other, no statistically significant change was detected in terms of Hydropic degeneration, Sinusoidal expansion, Disorganisation of hepatic cords, Inflammatory cell foci and Kupffer cells (p>0.05; p=0.549; p=0.513; p=0.134; p=0.317; p=1, respectively) (Table 4).

Table 4. Statistical comparison of cisplatin+β-glucan 3rd day 5th day groups

Data	n	3rd day Mean rank	5th day Mean rank	p
Hydropic degenerasyon	5	6,00	5,00	0,549
Sinuzoidal expansion	5	6,00	5,00	0,513
Disorganization of hepatic cords	5	6,50	4,50	0,134
Inflammatory cell foci	5	6,00	5,00	0,317
Kupffer cells	5	5,50	5,50	1,000

p=significance level; If p<0.05 is significant between groups.

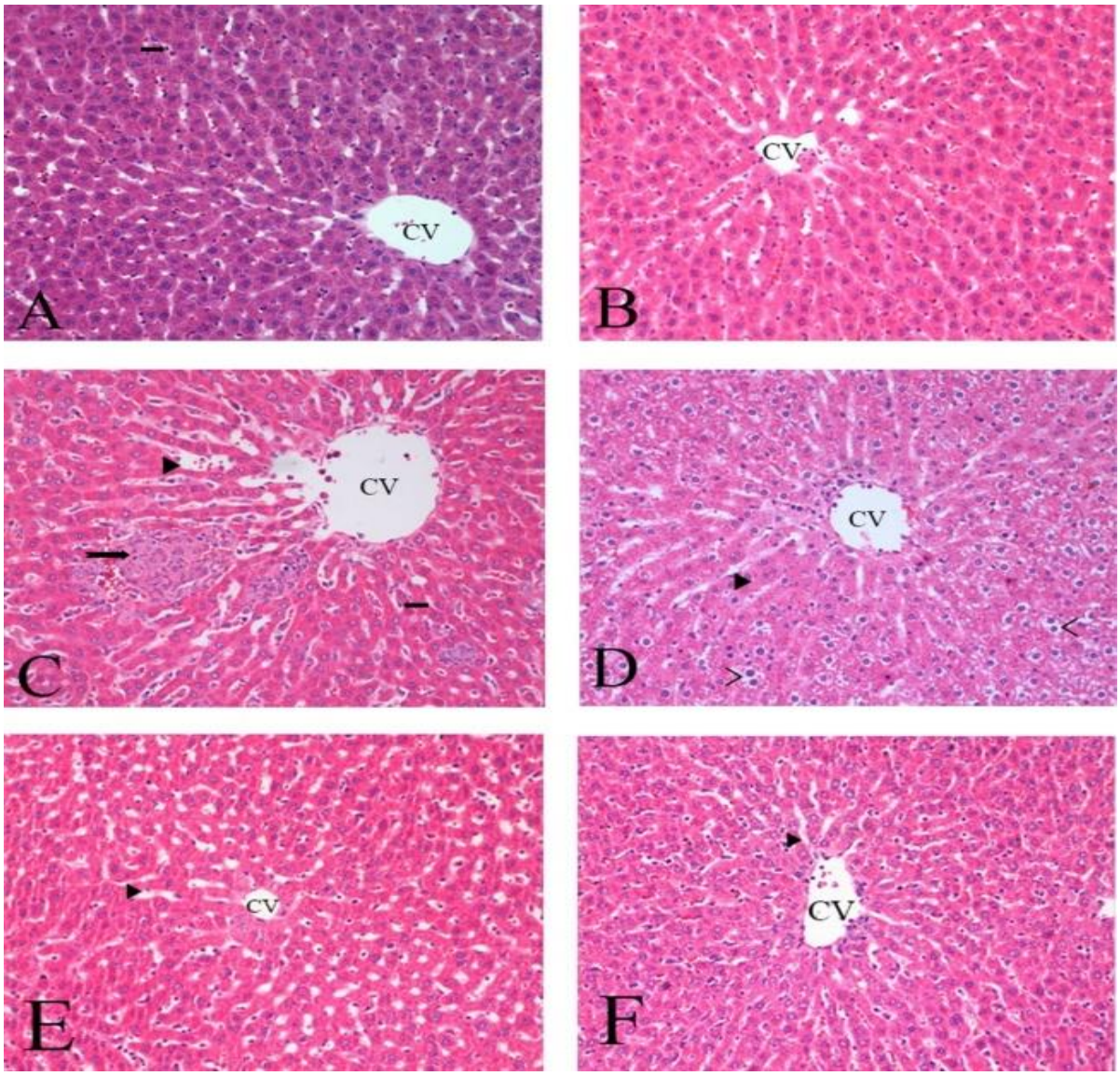

Figure 1. Histological observations of liver tissue in rat. A: Control, B: β-glukan 3rd day group, C: Cisplatin 3rd day group, D: Cisplatin 5th day group, E: Cisplatin+β-glukan 3rd day group, F: Cisplatin+β-glukan 5rd day group. Central ven (Cv), sinuzoidal congestion (arrowhead), inflammatory cell foci (notched arrow), hydropic hepatosit degenerasyon (<). Kuppfer cells (arrow). Hematoxylin&eosin x200.

DISCUSSION

The liver is an organ with an important role in the removal of toxic substances and detoxification of drugs. Therefore, liver tissue is exposed to the effects of many substances (Zhang et al., 2017). Although cisplatin is the most widely used antineoplastic drug, it causes unwanted side effects in the liver and many other tissues (İşeri et al., 2007). Cisplatin easily passes through the cell membrane, reaches the cell nucleus and changes the structure of DNA. Cisplatin causes hepatotoxicity in tissue by causing oxidative stress and apoptosis (Rady et al., 2023). It is recommended to use antioxidants with cisplatin to reduce hepatotoxicity caused by cisplatin (Kaymak et al., 2022; Pınar et al., 2019). In this study, toxic effects were examined in rat liver tissue on two different days (3rd day and 5th day) of cisplatin administration and the antioxidant activity of β-glucan was evaluated on these toxic effects.

Many studies have shown that cisplatin causes oxidative stress in the liver due to the formation of reactive oxygen species (ROS) such as superoxide and hydroxyl radicals (Avcı et al., 2008; Kurt et al., 2021). Removal of reactive oxygen species (ROS) from the cell is performed by endogenous antioxidants such as superoxide dismutase (SOD), catalase (CAT) and glutathione peroxidase (GPx) and non-enzymatic exogenous antioxidants such as transferrin, vitamin C, alpha-tocopherol (Ekinci-Akdemir et al., 2020; Valko et al., 2006,). Oxidative stress caused by accumulation of ROS and decrease in antioxidant defense system is an important factor in the formation of liver damage (Sherif et al., 2014). In a study, serum alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), lactate dehydrogenase (LDH), uric acid, urea, creatinine and interleukin-6 (IL-6) levels increased in cisplatin-treated rats. Malondialdehyde (MDA) and nitrogen monoxide (NO) levels were also significantly increased in hepatic tissue. In addition, glutathione (GSH) levels, SOD and CAT activities were decreased. These data cause histopathological changes in liver tissue (Abdel-Daim et al., 2020). In a study by Ekinci-Akdemir et al. (2020), liver damage was detected in rats administered 12 mg/kg cisplatin after 72 hours with an increase in MDA level and a remarkable decrease in GSH, GPx, SOD and CAT activities due to oxidative stress. Histopathological evaluation revealed coagulation necrosis, hydropic degeneration, sinusoidal dilatation and hyperemia. Studies have shown that cisplatin causes inflammatory cell infiltration, hyperplasia, periportal fibrosis, dilated blood sinusoids. In addition, karyomegaly and pyknotic nuclei were observed in hepatocytes (Abdel-Daim et al., 2020; El-Sayyad et al., 2009;). An electron microscopic examination showed that cisplatin 7 caused degeneration of cellular organs in rat liver, such as vesicular enlargement in the rough endoplasmic reticulum, especially mitochondria (Nasr et al., 2013).

In another study, the presence of inflammatory cells detected in liver tissue was attributed to the interaction of cisplatin with enzymes and proteins of interstitial liver tissue. As a result, cisplatin may interfere with the antioxidant defense mechanism and cause the formation of reactive oxygen species (Hakiminia et al., 2019). Cisplatin caused focal necrosis in some hepatocytes, which may be due to DNA inhibition (El-Hak et al., 2022). Kaymak et al. (2022) observed numerous hemorrhagic areas and necrotic cells in the cisplatin (7 mg/kg) group. In addition, while the histopathologic score was significantly higher in the cisplatin group, it was found that the score was insignificant in the group administered melatonin with cisplatin. Pınar et al. (2019) investigated the toxic effects of cisplatin (5 mg/kg) in rat liver and found significant perivenule sinusoid dilation, karyomegaly, pyknotic and karyolytic cells, central vein congestion, parenchymal inflammation, mildbileduct proliferation and periportal sinusoid dilation in an 11-day study. When the antioxidant Alpha lipoic acid was administered with cisplatin, this toxic damage was reduced. Rady et al. (2023) detected the toxic effects of cisplatin (7,5 mg) in liver tissue as hepatic structure disruption, congestion in central hepatic veins, lymphocytic infiltration, perivascular edema, hepatic cords disturbance, vacuolated cells, cellular necrotic area with condensed pyknotic nuclei.

As a result of the 3-day study conducted by Avcı et al. (2008), enlargement of sinusoids, hydropic degeneration and irregularities in hepatocytes, fibrosis around the central vein and enlarged periportal areas were observed in the group given cisplatin (10 mg/kg). In in previous study

where cisplatin was administered as a single dose (10 mg/kg, IP), hepatic function, histological changes, oxidative stress, inflammation, and apoptotic markers were detected in the examination of liver tissue (Habib et., 2020a). In our study, in parallel with these findings, mild hydropic degeneration in hepatocytes, especially around the central vein and portal area, as well as enlargement of sinusoids, disorganization in hepatic cords, inflammation foci and increase in Kupffer cells were detected in the cisplatin day 3 group. In a study by Koc et al. (2005), structural changes in the parenchyma around the central vein and hepatocellular vacuolization in these cells were observed in light microscopic images in the liver of the 5-day-old group given only cisplatin (10 mg/kg). Expansion in the sinusoids, formation of cell communities around the portal region, most of which consisted of plasma cells and lymphocytes, were clearly visible changes when the control group was compared with the cisplatin group. In the study conducted by İşeri et al. (2007), vacuolization in hepatocytes, degenerated hepatocytes, pyknotic nuclei, activation of Kupffer cells and dilated sinusoids were taken as criteria for liver damage caused by cisplatin. In our study, we found that hydropic degeneration in hepatocytes in the CP 5th day group spread throughout the whole liver tissue and this was found to be at a more moderate level compared to the 3rd day group. In addition, enlargement in sinusoids, disorganization in hepatic cords, increase in the distribution of inflammation foci and increase in Kupffer cells were found to be at a more moderate level compared to the 3rd day group.

In a study by Demirel Yılmaz et al. (2024), it was shown that liver damage caused by cisplatin started at mild level on day 2, increased on day 7 and started to decrease on day 14. In addition to these findings, in our study, there was a moderate change in hydropic degeneration on the 3rd day and cell damage was generally mild. In addition Demirel Yılmaz et al. (2024) found severe sinusoidal congestion on the 7th day in their study. The damage increase in on 5th day compared to 3rd day in our study shows that it will continue to increase in the following days. These and similar studies show that cisplatin causes oxidative stress, induces the release of free oxygen species and ultimately causes damage. İn addition these findings Habib et al. (2021b) found that cisplatin caused a major inflammatory response in liver tissues.

In order to withstand the adverse effects of cisplatin, many mechanisms have been proposed, including reducing drug accumulation, enhancing repair of damaged tissue and increasing detoxification factors (Beretta et al. 2008). The most appropriate method to reduce oxidative stress is the use of antioxidant substances (Quiles et al., 2002). A wide variety of antioxidant applications have been shown in studies to reduce and manage cisplatin toxicity (Rashid et. al. 2021).

In line with this information, the most effective dose of 100 mg/kg of β-glucan was used as an antioxidant substance in our study (Tohamy et al., 2003). No significant toxic effect was observed in the livers of rats injected with β-glucan by light microscopy. In the sisplatin+β-glucan 3rd day group, an almost normal image was obtained in the liver. In the examination, minimal inflammation foci, decrease in hydropic degeneration around the central veins, sinusoids close to normal appearance, and minimal increase in kupffers were determined. On sisplatin+β-glucan 5th day group, a histologic appearance close to normal was determined by decreasing the enlargement of sinusoids, hydropic degeneration, infiltrating cells, which were at moderate level compared to cisplatin 5th day group. In a study investigating the

antioxidant effects of β-Glucan on the biochemical and histopathological damages of ciplatin, it was found that β-Glucan reduces the oxidative and histopathological effects (Kaya et. al. 2024). These findings are parallel to our study.

According to these results, we can say that β-glucan, as a powerful antioxidant, reduces the damage caused by cisplatin in the liver. In a study conducted by Tohamy et al. (2003), it was determined that cisplatin, an anticancer drug, caused the formation of excessive amounts of reactive oxygen species in the cellular environment, which are not normally present in the cellular environment, and the antioxidant β-glucan scavenged these reactive oxygen species. In a study investigating the effects of β-glucan on the toxicity of the environmental pollutant 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD), β-glucan (50 mg/kg/day) was applied for 3 weeks. As a result of histopathological and biochemical findings, it was determined that the toxicity caused by TCDD in the brain and liver tissue was improved by β-glucan application (Turkmen et.al. 2022). In addition, it has been shown in previous studies that β-glucan may protect tissues against oxidative damage with its effect of scavenging free radicals (Demirel Yılmaz et al., 2024; Karaduman et al., 2010; Şener et al., 2006).

CONCLUSION

In the light of our findings, it was shown that cisplatin induced histopathological changes in the tissues by stimulating the production of free oxygen radicals in two different day groups (3rd day and 5th day). On this histopathologic change, β-glucan was found to reduce the damage caused by cisplatin by scavenging free oxygen radicals in both day groups.

The role of β-glucan on the molecular and histological changes induced by cisplatin on tissues can be supported by further studies on rats by applying different combinations.

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References

Abdel-Daima, M. M., Abdel-Rahmanc, H. G., Dessoukid, A. A., El-Fare, A. H., Khodeerf, D. M., Bin-Jumahg, M., Alhaderh, M. S., Alkahtania, S., Aleyai, L. (2020). Impact of garlic (Allium sativum) oil on cisplatin-induced hepatorenal biochemical and histopathological alterations in rats. *Science of The Total Environment, 710*, 136338.

Akaras, N., Abuc, O. O., Koc, K., Bal, T., Geyikoglu, H. (2020). (1→3)-β-d-glucan enhances the toxicity induced by Bortezomib in rat testis. *J Food Biochemica, 44*(3), e13155.

Al-Majed, A. A. (2007). Carnitine Deficiency Provokes Sisplatin-Induced Hepatotoxicity in Rats. *Basic&Clinical Paharmacology, 100,* 145-150.

Avcı, A., Çetin, R., Ergüder, İ. B., Devrim, E., Kılıçoğlu, B. (2008). Cisplatin causes oxidation in rat liver tissues: possible protective effects of antioxidant food supplementation. *Turkish J Med Sci, 38*(2), 117-120.

Beretta, G. L., Gatti, L., Corna, E., Carenini, N., Zunino, F. (2008). Defining targets of modulation of human tumor cell response to cisplatin. *Journal of Inorganic Biochemistry, 102,* 1406-1415.

Demirel Yılmaz, B., Eren, B., Sağır, D., Başardı, A., Mercan, S. (2024). Histological Evaluation of the Protective Role of β-glucan Against Cisplatin-Induced Hepatotoxicity. Karamanoğlu Mehmetbey University *Journal of Engineering and Natural Sciences, 6*(1), 38-43.

Ekinci-Akdemir, F. N., Bingöl, Ç., Yıldırım, S., Kandemir, F. M., Küçükler, S., Sağlam, Y. S. (2020). The investigation of the effect of fraxin on hepatotoxicity induced by cisplatin in rats. *Iran J Basic Med Sci, 23*, 11.

El-Hak, H. N. G., Mahmoud, H. S., Ahmed, E. A., Elnegris, H. M., Aldayel, T. S., Abdelrazek, H. M. A., Soliman, M. T. A., El-Menyawy, M. A. I. (2022). Methanolic Phoenix dactylifera L. Extract Ameliorates Cisplatin-Induced Hepatic Injury in Male Rats. *Nutrients, 14,* 1025.

El-Sayyad, H. I., Ismail, M. F., Shalaby, F. M., Abou-El-Magd, R. F., Gaur, R. L., Fernando, A. (2009). Histopathological effects of cisplatin, doxorubicin and 5-flurouracil (5-FU) on the liver of male albino rats. *Int. J. Biol. Sci., 5,* 466-473.

Florea, A. M., Busselberg, D. (2011). Cisplatin as an anti-tumor drug: cellular mechanisms of activity, drug resistance and induced side effects. *Cancers (Basel), 3*(1), 1351-71.

Fouad, A. A., Morsy, M. A., Gomaa, W. (2008). Protective Effect of Carnosine Against Sisplatin-Induced Nephrotoxicity in Mice. *Enviromental Toxicology and Pharmacology, 25,* 292:297.

Gardiner, T. (2000). A Review: Beta-glucan Bilogical Activities. *GlycoScience, 1*(32), 1-6.

Güleç, M., Yılmaz, H. R., Iraz, M., Ağlamış, S., Söğüt, S. (2004). Sisplatinin Böbrek Metabolizması Üzerine Etkileri: Gingo Biloba Ekstraktının Koruyuculuğu. *Türkiye Klinikleri J. Med. Sci., 24*, 585-591.

Habib, S. B, Abdelrahman, R. S., Rahim, M. A., Suddek, G. M. (2020a). Anti-apoptotic effect of vinpocetine on cisplatin-induced hepatotoxicity in mice: The role of Annexin-V. Caspase-3, and Bax. *J Biochem Mol Toxicol. 34*(10):e22555.

Habib, S., Suddek, G. M., Rahim, M. A. Abdelrahman, R. S. (2021b). The protective effect of protocatechuic acid on hepatotoxicity induced by cisplatin in mice. *Life Sci. 15*:277:119485.

Hakiminia, B., Goudarzi, A., Moghaddas, A. (2019). Has vitamin E any shreds of evidence in cisplatin-induced toxicity. J. *Biochem. Mol. Toxicol, 33*, e22349. DOI: 10.1002/jbt.22349

Hamad, R., Jayakumar, C., Ranganathan, P., Mohamed, R., El-Hamamy, M. M. I., Dessouki, A. A, Ibrahim, A. (2015). Honey feeding protects kidney against cisplatin nephrotoxicity through suppression of inflammation. *Clinical and Experimental Pharmacology and Physiology, 42*(8), 843-848.

İşeri, S., Ercan, F., Gedik, N., Yüksel, M., İnci, Alican. (2007). Simvastatin Attenuates Sisplatin-Induced Kidney and Liver Damage in Rats. *Toxicology, 230*, 256-732.

Karaduman, D., Eren, B., Keles, O. N. (2010). The protective effect of Beta-1,3-D-glucan on taxol induced hepatotoxicity: a histopathological and stereological study. *Drug and Chemical Toxicology, 33*(1), 8-16.

Kaya, K., Cifci, O., Turkmen, N. B., Taşlıdere, A., Gül, A. A. (2024). β-Glucan ameliorates cisplatin-induced oxidative and histological damage in kidney and liver of rats. *Biotechnic & Histochemistry. 99,* 2.

Kaya, K., Citfci, O., Aydın, M., Cetin, A., Basak, A. (2019). Favourable effect of β-glucan treatment against cisplatin-induced reproductive system damage in male rats. *Andrologia, 51*, e13342.

Kaymak, E., Ünsal, M., Akın, A. T., Öztürk, E., Ceylan, T., Kuloğlu, N., Karabulut, D., Yakan, B. (2022). Protective effect of melatonin on cisplatin-induced liver injury in rats. *Çukurova Medical Journal, 47*(1), 250-258.

Kesim, S. M., Şahan, C., Güner, E. (2001). Hepatik İlaç Metabolizması. *OMÜ Tıp Dergisi, 18*(2), 154-160.

Koc, A., Duru, M., Ciralik, H., Akcan, R., Sogut, S. (2005). Protective agent, erdosteine, against cisplatin-induced hepatic oxidant injury in rats. *Molecular Cell Biochemistry, 278* (1-2), 79-84.

Kurt, N., Türkeri, Ö. N., Suleyman, B., Bakan, N. (2021). The effect of taxifolin on high-dose-cisplatin induced oxidative liver injury in rats. *Adv Clin Exp Med., 30*(10), 1025-1030. Doi: 10.17219/acem/138318.

Mansour, H. H., Hafez, F. H., Fahmy, N. M. (2006). Silymarin modulates cisplatin-induced oxidative stres and hepatotoxicity in rats. *Journal Biochemical Molecular Biology, 30*; 39(6), 656-61.

Nasr, A. Y. (2013). Morphological, biochemical, histological, and ultrastructural protective effects of misoprostol on

cisplatin induced-hepatotoxicity in adult male rats. *Saudi Medical Journal, 34,* 1237–1247.

Palipoch, S., Punsawad, C. (2013). Biochemical and histological study of rat liver and kidney injury induced by cisplatin. *Journal Toxicol Pathology, 26*, 293-299.

Pınar, N., Çakırca, G., Hakverdi, S., Kaplan, M. (2019). Protective effect of alpha lipoic acid on cisplatin induced hepatotoxicity in rats. *Biotechnic&Histochemistry, 95*(3), 219-224. doi: 10.1080/10520295.2019.1667025.

Quiles, J. L., Huertas, J. R., Battino, M., Mataix, J., Ramirez-tortorsa, M. C. (2002). Antioxidant Nutrients and Adriamycin Toxicity. *Toxicology, 180*, 79-95.

Rady, M., Yosry, O., Hassaan, H., Nofal, A. E. (2023). Hepatoprotective Effect of Gum Arabic Versus Cisplatin Hepatotoxicity in Adult Male Rats: Biochemical, Histological and Ultrastructural Studies. *Egypt. J. Chem. 66*(10), 377-387.

Rashid, N. A., Halim, S. A. S. A., Teoh, S. L., Budin, S. B., Hussan, F., Ridzuan, H. N. R., Jalil, N. A. A. (2021). The role of natural antioxidants in cisplatin-induced hepatotoxicity. *Biomedicine& Pharmacotherapy, 144*, 112328.

Sherif, I. O., Abdel-Aziz, A., Sarhan, O. M. (2014). Cisplatin-induced testicular toxicity in rats: the protective effect of arjunolic acid. *J Biochem Mol Toxicol, 28*, 515-521.

Söğüt, S., Yılmaz, H. R., Songur, A., Güleç, M., Kotuk, M. (2004). Sıçanlarda cisplatin ile oluşturulan nefrotoksisitede bazı metabolik enzim aktiviteleri ve bunlar Üzerine E vitaminin etkileri. *Tıp Araştırmaları Dergisi, 2*(1), 23-28.

Şener, G., Eksioğlu, Demiralp, E., Çetiner, M., Ercan, F., Yeğen, B. C. (2006). β-glucan ameliorates methotrexate-induced oxidative organ injury via its antioxidant and immunomodulatory effects. *European J of Pharmacology, 542*, 170-178.

Şener, G., Toklu, H. Z., Cetinel, Ş. (2007). Beta-glucan protects against chronic nicotine-ınduced oxidative damage in kidney and bladder. *Environmental Toxicology and Pharmacology, 23*, 25-32.

Tatli Seven, P., Iflazoglu Mutlu S., Seven, I., Arkali, G., Ozer Kaya S., Kanmaz, O. S. (2021). Protective role of yeast beta-glucan on lead acetate-induced hepatic and reproductive toxicity in rats. *Environmental Science and Pollution Research, 38*, p. 53668-53678.

Tohamy, A. A., El-Ghor, A. A., El-Nahas, S. M., Noshy, M. (2003). Beta-glucan inhibits the genotoxicity of cyclophosphamide, adriamycin and cisplatin. *Mutation Research, 541*(1-2), 45-53.

Topçu Tarladaçalışır, Y., Uygun, M., Akpolat, M., Uz, Y. H., 2005. E ve C Vitaminlerinin Sisplatin Hepatoksisistesini Önlemedeki Etkilerinin Histolojik olarak İncelenmesi. *Trakya Üniv. Tıp Fak. Dergisi. 22*(3), 124-131.

Turkmen, N. B., Ozek, D. A., Taslidere, A., Dogan, F., Ciftci, O. (2022). Beta-glucan effects on 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) toxicity in liver and brain. *Biotechnic&Histochemistry, 97*, 6.

Valko, M., Rhodes, C. J., Moncol, J., Izakovic, M., Mazur, M. (2006). Free radicals, metals and anti-oxidants in oxidative stress-induced cancer. *Chem Biol Interact, 160,* 1-40.

Yılmaz, H. R., Söğüt, S., Özyurt, H., Iraz, M., Yıldırım, Z. (2004). Sıçanlarda sisplatinle oluşturulan nefrotoksisitede metabolik enzim aktivitelerine kafeik asit fenetil esterin etkisi. *Van Tıp Dergisi, 11*(1),1-6.

Zhang, J. J., Meng, X., Li, Y., Zhou, Y., Xu, D. P., Li, S. (2017). Effects of melatonin on liver injuries and diseases. *Int J Mol Sci, 18,* 673.

NORTHERN JOURNAL of HEALTH SCIENCES

Review Article

Obesity Prevalence in World and Türkiye

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Abstract

Obesity, which now affects one in three people, is considered the disease of our time. When body weight increases abnormally, regardless of a person' s control, excess fat tissue accumulates in the body. Obesity is indicated by factors such as body mass index (BMI), waist circumference measurements, and other anthropometric measurements. Environmental factors, such as poor and inadequate nutrition, contribute to the development of obesity, as does the adoption of a sedentary lifestyle. Genetic and etiological factors also play a role. Obesity affects not only the individual but also society as a whole. If unhealthy eating habits established in adolescence persist into adulthood, individuals may struggle to achieve a balanced and adequate diet, leading to health problems. The main objectives in the fight against obesity are to promote a balanced diet and to encourage lifestyle changes, including physical activity. This study was compiled by collecting data from secondary sources about obesity and its prevalence globally and in Türkiye.

Keywords: Balanced Nutrition, Causes of Obesity, Obesity

INTRODUCTION

Optimal nutrition ensures a healthy life with maximum well-being and minimal disease risk. The primary goal of optimal nutrition is to meet metabolic needs and provide sufficient energy and essential nutrients for the body to function. Obesity occurs when a person's body mass exceeds the appropriate weight relative to their height or when their energy intake exceeds their energy expenditure. In other words, obesity results from an excessive accumulation of fat mass in the body.

As a person's weight increases and reaches obesity levels, metabolic and endocrine changes occur. If weight gain is not controlled, obesity can lead to a variety of health problems, including high blood pressure, skin disorders, mental health problems, respiratory problems, altered blood lipid profiles, musculoskeletal problems, and diabetes. Obesity is a multifactorial metabolic disorder.

Obesity is a complex, heterogeneous, chronic, and unfortunately progressive disease that significantly impacts health, quality of life, and mortality (Lingvay et al., 2024).

In 1997, the World Health Organization (WHO) declared obesity a major public health issue and a global epidemic. Generally, a body mass index of 25 kg/m² or higher is considered overweight, while 30 kg/m² or higher is classified as obese (Haththotuwa et al., 2020; Lingway et al., 2024). In adults, the percentage of body fat in the body mass index (BMI) typically ranges from 15-18% for men and 20-25% for women. When the percentage of body fat exceeds 20% in men and 30% in women, obesity is diagnosed if weight gain is persistent. Anthropometric measurements are used to assess obesity, and it is essential to consider several measurements rather than relying solely on one.

Hunger and obesity can affect people from all walks of life. Food insecurity is a global problem that transcends economic boundaries. Interestingly, the prevalence of obesity-related deaths worldwide is higher than hunger-related deaths, highlighting that obesity is a significant problem alongside hunger. Nutrition goes beyond simply filling the stomach; it plays a critical role in overall health. The most crucial step in preventing obesity is ensuring everyone has convenient access to nutritious food and makes healthy choices.

Obesity

Obesity occurs when an excessive and disproportionate amount of fat accumulates in the body, adversely affecting health. The prevalence of obesity is steadily increasing, making it a critical health issue of our time. In general, obesity is defined as a body mass index (BMI) of ≥30 kg/m² in adults aged 20 years and older, regardless of sex or age (CDC, 2023a).

Obesity not only affects the health of individuals but also has broader societal implications. It leads to various diseases and can cause physiological, endocrinological, aesthetic, psychological, and sociological problems. Obesity is associated with increased mortality, reduced health-related quality of life, and increased disease burden and healthcare costs.

Obesity arises from the interaction of many factors, including genetic, metabolic, behavioral, and environmental influences. With serious social and psychological effects, obesity significantly contributes to the global burden of chronic disease and disability, impacting all age and socioeconomic groups (Haththotuwa et al., 2020).

In recent years, the prevalence of obesity in children has increased dramatically. Overweight children have a high likelihood of becoming obese adults and face an increased risk of

developing noncommunicable diseases later in life. Due to these trends, global health targets in nutrition surveillance have focused not only on undernutrition but also on all forms of malnutrition, including overweight and obesity (Bixby et al., 20025). These efforts have also led to an increase in the budget allocated for obesity prevention.

A report by the Organisation for Economic Co-operation and Development (OECD) found that obese people tend to use health services more frequently. Overweight people spend about 2.5 times more on healthcare than those with a healthy body weight. According to the OECD, obesity-related spending will be a significant financial burden for the United States between 2020 and 2050. The same report predicts that 12% of our country's healthcare spending will be on obesity-related diseases (OECD, 2017). In Europe, spending on obesity-related diseases is much lower than in the US and our country. The World Health Organisation (WHO) reports that 6% of health expenditure in the European Region is spent on treating obesity (WHO, 2000).

Obesity Prevalence in the World

According to the World Health Organization (WHO), the global prevalence of obesity nearly tripled between 1975 and 2016. In 2016, more than 1.9 billion adults aged 18 years and older were overweight, and more than 650 million of them were classified as obese. In addition, an estimated 38.2 million children under the age of 5 were overweight or obese in 2019. Notably, the prevalence of overweight children under 5 in Africa has increased by about 24% since 2000, and in 2019, about half of all overweight or obese children under 5 lived in Asia (WHO, 2003).

From a broader perspective, obesity, once considered primarily a problem in high-income countries, is now widespread in low- and middle-income countries and in rural areas. If there are no positive changes in dietary habits and obesity rates continue to rise, it is estimated that 20% of the world's population will be obese by 2030 (WHO, 2000).

The World Obesity Federation's (WOF) 2016 report estimates that obesity will affect around 770 million adults worldwide by 2020. With immediate action, this number will be one billion by 2030 (WOF, 2023a). Interestingly, Nauru holds the title of the most obese country in the world, with 59.85% of its adult male population classified as obese. In contrast, Vietnam has the lowest risk of adult male obesity, with a rate of 1.67% (WOF, 2023b).

According to the 2003-2004 US National Nutrition and Health Survey conducted by the Centers for Disease Control and Prevention (CDC), obesity, defined as a BMI greater than 30, was higher in both men and women. Specifically, it was 31.1% in women and 33.2% in men then. The subsequent study, conducted in 2005-2006, reported slightly higher figures: 33.3% for men and 35.3% for women (CDC, 2023b).

EU statistics compiled by Eurostat (2023) cover EU countries, including Norway, Serbia, and Turkey. They show that weight problems and obesity are increasing rapidly in all countries. The study looked at the rates of overweight and obese adults in the EU between 2018 and 2020. In 2019, the highest rates of obesity among women will be found in Malta. Conversely, the lowest female obesity rates (low to high) were found in Italy, Romania, and Bulgaria. Among men, the highest rates were found in Romania, Italy, the Netherlands, and France. The countries with the highest obesity rates (from high to low) for women were Estonia, Latvia, Ireland, and Malta. For men, these countries were Croatia, Ireland, Hungary and Malta. The same study also highlighted that obesity rates tend to be higher in men than in women. In addition, obesity tends

to increase with age, and women's level of education appears to be inversely correlated with obesity. However, there is no significant association between educational attainment and obesity in men.

Obesity Prevalence in Türkiye

Obesity, a condition characterized by excess body fat, is one of the significant health challenges affecting individuals from childhood through adolescence and into adulthood. The prevalence of overweight and obesity has increased significantly worldwide, affecting both children and adults.

Obesity is a major public health problem affecting a significant portion of the Turkish population. In the last 20 years, the prevalence of obesity among adults has increased significantly. In 1990, 18.8% of the adult population was obese (28.5% among women and 9% among men), and this rate rose to 36% in 2010 (44% among women and 27% among men) (Erem 2015). In a study investigating the BMI data of women visiting the Cancer Early Diagnosis and Screening Center (KETEM) in Türkiye, the prevalence of obesity among adult women aged 35-60 was found to be 35%. The highest prevalence was observed in Western Turkey, in the Aegean region, where 42% of women had a BMI over 30. The lowest rate was observed in Eastern Turkey, with 21% of women being obese, followed by 28% in Southeastern Turkey (Ozgul et al., 2011).

According to health research in Turkey:
- In 2008, the BMI rate for obese people aged 15 and over was 15.2%.
- By 2019, this rate had increased to 21.1%.
- Looking at gender-specific data for 2019, 24.8% of women and 17.3% of men were classified as obese (TUIK, 2019).

In the young population (15-24 years), the Turkish Health Survey reported the following obesity rates:
- In 2016, the obesity rate was 3.8%, which increased to 4.6% in 2019.
- For young men, the obesity rate was 3.5% in 2016 and 4.8% in 2019.
- For young women, the rates were 3.8% in 2016 and 4.5% in 2019 (TUIK, 2019).

In addition, the rate of non-obese normal-weight individuals (aged 15-24) decreased from 66.4% in 2016 to 64.3% in 2019. This rate was 63.6% for young women in 2016 and 64.3% in 2019 (TUIK, 2019).

According to the World Obesity Federation (WOF, 2023b):
- In 2016, 25.29% of adult males in Turkey were classified as obese, ranking 44th worldwide in terms of obesity prevalence.
- Among women, 20.71% were classified as obese, ranking 24th in the world.
- For boys, the obesity rate was 12.18% (73rd in the world).
- For girls, the rate was 10.92% (54th in the world).

Furthermore, WOF (WOF, 2023a) predicts that by 2022, 20.2% of adults aged 15 years and over in Turkey will be obese.

These findings highlight the urgent need for effective strategies to tackle obesity and promote healthier lifestyles, particularly emphasizing the necessity of combating obesity among women.

Causes, Detection, and Prevention of Obesity

The leading causes of obesity can be categorized as etiological, environmental (related to eating habits and lack of physical activity), and genetic. Etiological factors include certain medications, hormone treatments, hypothalamic surgery, neuroendocrine, and nutritional obesity. Typical forms of diet-related obesity include eating disorders that begin between 0 and 2 years of

age, hyperphagic obesity that begins in childhood and is characterized by continuous weight gain, frequent consumption of high-fat, high-energy foods, psychological issues, socioeconomic status, sedentary lifestyle, and aging.

When assessing obesity based on genetic factors:
- If both parents are thin, the obesity rate is 10-15%.
- If the mother is thin and the father is obese, the rate rises to 40-50%.
- If both parents are obese, the rate rises to 80%.
To detect obesity, the World Health Organization (WHO) recommends using the Body Mass Index (BMI), which assesses whether an individual's weight/height ratio is within a healthy range (Nishida et al., 2004). BMI is a commonly used method for detecting obesity because of its simplicity and practicality. It is calculated by dividing a person's weight in kilograms by their height in square meters. However, BMI alone does not consider variations in body structure between individuals, so it is essential to consider additional methods of assessing obesity.

The WHO defines individuals over 18 with a BMI of 30 kg/m² and above as having first-degree obesity, while those with a BMI of 25 to 29.9 kg/m² are considered overweight (Baysal et al. 2014). As obesity is characterized by the accumulation of fat in the body, reliance on BMI alone may not be a comprehensive indicator of fat content.

While measuring waist circumference is one of the most commonly used methods, other anthropometric measures such as waist-to-hip ratio or waist-to-height ratio can be appropriate, considering factors such as age, gender, and disease risk.

The obesity epidemic requires timely and effective population-based approaches to prevent the condition. Obesity can be largely prevented by adopting healthy lifestyles that include healthy eating and adequate physical activity. In many countries, there is a need for the development of national policies and the implementation of population-based intervention programs to combat the obesity epidemic and promote public health (Lim et al.; 2020).

Obesity is also a concerning health issue in Türkiye and shows an increasing trend over time. Yumuk (2005) emphasized the need for national surveys to demonstrate the magnitude of obesity among children.

Santas and Santas (2018) noted that there is a relationship between education level and obesity rates, particularly among women in Türkiye. Women who did not receive education or did not complete primary school, as well as those who were not working, have a higher risk of obesity. Obesity increased in proportion to the number of births among mothers. It was most commonly observed in the Western and Central regions. As household welfare increased, obesity also rose.

Ercan et al. (2012) reported in their study that the increase in computer and screen time affects the obesity rates of adolescents. It was observed that the body mass index (BMI) also increased with the increase in computer usage. A greater proportion of overweight and obese adolescents watched TV and used computers for more than 2 hours per day compared to their normal-weight peers. Normal-weight individuals were found to have a higher participation rate in regular physical activity. The prevalence of obesity among the families of obese adolescents was 56.5%.

Obesity is a major global health problem. The most effective strategy for preventing obesity is to instill healthy eating habits and promote physical activity from an early age. Educating children about food ingredients, the risks of unhealthy diets, and the importance of avoiding fast food is crucial. Regular weight monitoring is also essential.

CONCLUSION

Diet plays a crucial role in the fight against obesity. Obesity is a preventable, treatable, and manageable disease. The most crucial step to prevent and control obesity is to eat a balanced and nutritious diet. In addition, lifestyle changes and regular physical activity contribute to overall health.

For a well-balanced diet: Aim to consume a variety of fresh fruits and vegetables daily. Choose seasonal produce whenever possible. Include whole grains in your diet, such as whole wheat bread, brown rice, and oats. Add pulses like lentils, chickpeas, and beans as sources of protein and fiber. Try to consume 2-3 servings of milk and dairy products each day. Eating fish at least 2-3 times a week (about 300-500 grams) provides essential nutrients and healthy fats. Also, pay attention to your daily fluid intake to stay hydrated. Additionally, choose different food groups at each meal.

Culturally appropriate programs and policies that promote nutritious diets within caloric requirements can help reduce overweight and obesity. In addition, public health initiatives that encourage physical activity help to maintain a healthy weight.

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References

Baysal, A., Aksoy, M., Besler, T., Bozkurt, N., Keçecioğlu, S., Merdol, T.K. (2014). Diyet El Kitabı. 8. Baskı. Ankara, Hatiboğlu Yayınevi.

Bixby, H., Mishra, A., & Martinez, A. R. (2025). Worldwide levels and trends in childhood obesity. In Childhood Obesity (pp. 21-40). Academic Press.

CDC, (2023a). https://www.cdc.gov/obesity/data/prevalence-maps.html

CDC, (2023b). https://www.cdc.gov/nccdphp/dnpao/state-local-programs/fundingopp/2023/hop.html.

Ercan, S., Dallar, Y. B., Önen, S., & Engiz, Ö. (2012). Prevalence of obesity and associated risk factors among adolescents in Ankara, Turkey. Journal of clinical research in pediatric endocrinology, 4(4), 204.

Erem, C. (2015). Prevalence of overweight and obesity in Turkey. IJC Metabolic & Endocrine, 8, 38-41.

Eurostat, (2023). https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Overweight_population_map_July_2021_V2.png.

Haththotuwa, R. N., Wijeyaratne, C. N., & Senarath, U. (2020). Worldwide epidemic of obesity. In Obesity and obstetrics (pp. 3-8). Elsevier.

Lim, H. J., Xue, H., & Wang, Y. (2020). Global trends in obesity. Handbook of Eating and Drinking: Interdisciplinary Perspectives, 1217-1235.

Lingvay, I., Cohen, R. V., le Roux, C. W., & Sumithran, P. (2024). Obesity in adults. The Lancet, 404(10456), 972-987.

Nishida, C., Barba, C., S-Froza, C., (2004). Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. The Lancet, 363(9403): 157-63.

OECD, (2017). Obesity update - OECD 2017 https://www.oecd.org/els/health-systems/Obesity-Update-2017.pdf .

Ozgul, N., Tuncer, M., Abacioglu, M., & Gultekin, M. (2011). Prevalence of obesity among women in Turkey: analysis of KETEM data. Asian Pacific Journal of Cancer Prevention, 12(9), 2401-2404.

Santas, F., & Santas, G. (2018). Obesity among women in Turkey. Iranian Journal of Public Health, 47(5), 682.

TUIK, (2019). TÜİK, Türkiye Sağlık Araştırması, 2016, 2019 (https://data.tuik.gov.tr/Bulten/Index?p=Istatistiklerle-Kadin-2020-37221.

WHO, (2000) Obesity: Preventing and managing the global epidemic. World Health Organization: Technical Report Series. In WHO Technical Report Series; 2000. no. 894.

WHO, (2023). Obesity and overweight. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight

WOF, (2023 b). https://data.worldobesity.org/rankings/

WOF, (2023a). Prevalence of Obesity. https://www.worldobesity.org/about/about-obesity/prevalence-of-obesity.

Yumuk, V. D. (2005). Prevalence of obesity in Turkey. Obesity Reviews, 6(1), 9-10

NORTHERN JOURNAL of HEALTH SCIENCES

Case Report

A Case of Bilateral Bifid Rib Misinterpreted as a Fracture in Post-Trauma Computed Tomography

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Abstract

Chest trauma frequently results in injuries to the ribs and soft tissues, often requiring imaging to differentiate fractures from other conditions. A 56-year-old female presented with chest pain after a fall, and an initial chest X-ray raised suspicion of a rib fracture. A follow-up computed tomography (CT) scan also suggested a displaced fracture of the left seventh rib. However, upon detailed review and 3D reconstruction of the CT images, a congenital bifid deformity of the left seventh and right sixth ribs was identified. This anomaly was initially misinterpreted as a fracture. Bifid ribs, a rare congenital anomaly found in less than 2% of the population, are typically asymptomatic and discovered incidentally. In this case, the patient' s pain was attributed to soft tissue injury rather than the bifid rib. Conservative management with analgesics resolved the symptoms. The case highlights the importance of advanced imaging techniques, such as 3D CT, in accurately diagnosing congenital rib anomalies to avoid unnecessary interventions.

Keywords: Bifid Rib, Rib Fracture, Chest Trauma, Computed Tomography, 3D Reconstruction

INTRODUCTION

The evaluation of chest wall injuries following trauma requires a comprehensive approach that combines a detailed physical examination with appropriate radiological imaging. This is crucial not only for identifying visible injuries but also for uncovering subtle or underlying pathologies. Radiographs (X-rays) are often the first-line imaging modality in trauma cases, helping to visualize fractures or other skeletal abnormalities. However, computed tomography (CT) plays a vital role in situations where more detailed visualization of bone structures, soft tissue, and pulmonary parenchyma is required. CT scans offer a higher resolution, allowing for a more accurate diagnosis of fractures, dislocations, and soft tissue injuries that might be missed on conventional radiographs (Trauma Imaging, 2016).

In particular, the use of 3D reconstruction techniques in CT imaging can provide an enhanced view of anatomical structures, which is especially beneficial in cases where standard axial, coronal, and sagittal views may lead to ambiguous findings or misdiagnosis (Özgür et al., 2018). Rib fractures are a common complication following chest trauma, and careful evaluation of the costal anatomy is essential to distinguish true fractures from congenital anomalies or variations such as bifid ribs. Bifid rib, though rare, can be mistaken for a fracture, potentially leading to unnecessary treatments if not accurately identified (Cheng et al., 2019; Silva et al., 2017). We are presenting such case.

Case Report

A 56-year-old female presented to the emergency department following a low-energy trauma, specifically a fall from the same level. Upon initial evaluation, the patient reported localized pain in the upper left side of her chest, specifically around the upper portion of the costal margin. There was no significant history of prior chest trauma or congenital anomalies related to the skeletal system. A chest X-ray was performed to assess for possible fractures, and the initial radiograph raised suspicion of a fracture in the left seventh rib. Due to the inconclusive findings on the X-ray and ongoing pain, further imaging with a thoracic CT scan was deemed necessary.

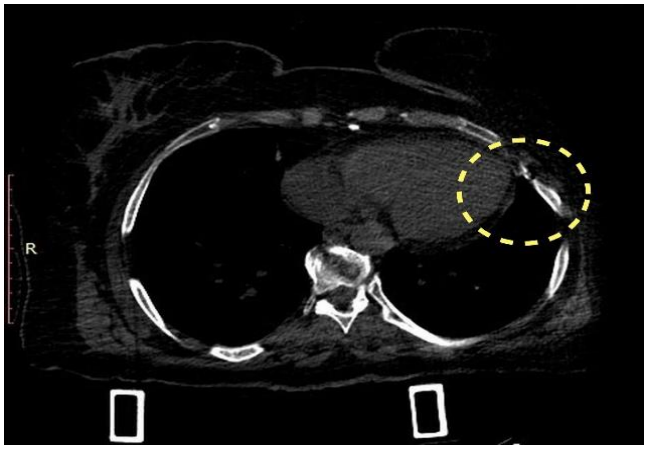

Figure 1. Computed Tomography section showing a suspected displaced rib fracture on the left side

The CT scan was reviewed, and a displaced fracture of the left seventh rib was reported by the radiologist. The patient was subsequently referred to the Thoracic Surgery department for further consultation. On physical examination, there was tenderness to palpation over the region of the suspected fracture, but no visible signs of ecchymosis, swelling, or deformity were noted. Despite the reported fracture on the initial CT review (Figure 1), the clinical findings were not fully consistent with the severity of a displaced rib fracture.

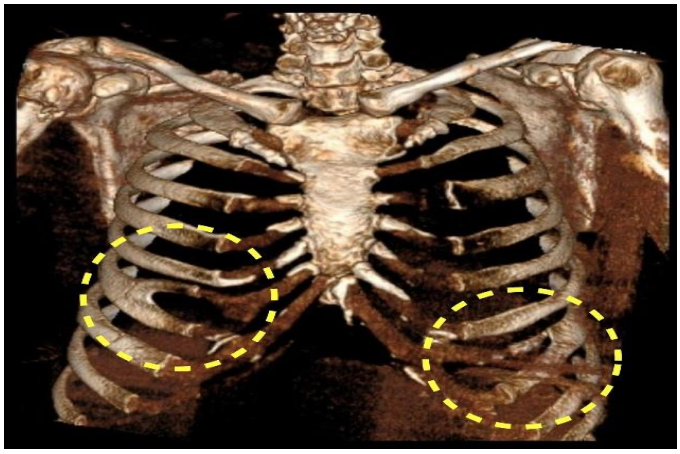

Figure 2. Three-dimensional reconstruction of computed tomography images indicated bilateral bifid costae.

A more detailed evaluation of the CT images was performed, including a multi-planar review in axial, sagittal, and coronal views. No definitive evidence of a fracture was identified on closer inspection. Given the discordance between the initial report and the clinical findings, a 3D reconstruction of the thoracic CT was performed for more accurate visualization (Figure 2). This revealed that the left seventh rib exhibited a bifid morphology, characterized by a congenital division of the rib into two parts, which could be mistaken for a fracture on standard imaging. Interestingly, a similar bifid deformity was also observed in the right sixth rib (Figure 3A-B). Both of these findings were deemed to be anatomical variations rather than trauma-induced fractures.

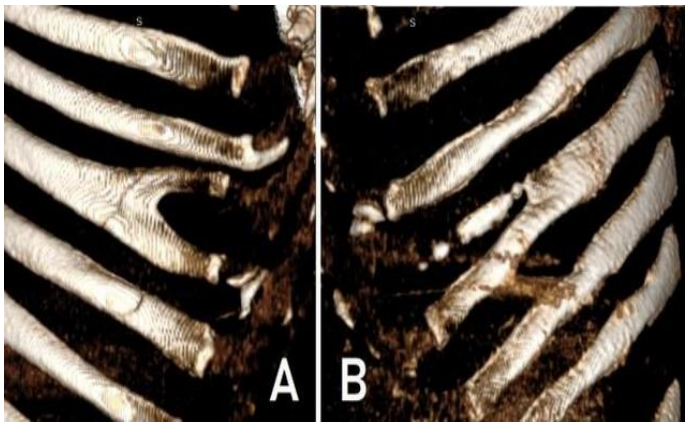

Figure 3. Close-up three-dimensional reconstruction images of bifid costae in right (A) and left (B) side.

Given that the bifid ribs had no adverse impact on the patient's thoracic integrity or respiratory mechanics, no surgical intervention or specific treatment for the ribs was necessary. The patient's pain was attributed to soft tissue contusion related to the trauma rather than the bifid ribs. She was managed conservatively with analgesics, and regular outpatient follow-up was recommended. At her follow-up visit two weeks later, the patient reported a significant resolution of her symptoms, with no further chest pain.

DISCUSSION

Bifid rib is a rare congenital anomaly of the chest wall, in which a rib is partially divided into two segments. It is classified among chest wall deformities and occurs in less than 2% of the population, although its prevalence may vary depending on the population studied (Özcanlı et al., 2021)). This condition is typically asymptomatic and is often discovered incidentally during imaging performed for unrelated reasons, such as trauma or routine screenings. In most cases, bifid ribs do not cause any functional impairment or significant clinical symptoms, although they can occasionally be associated with syndromic conditions, such as Gorlin syndrome (nevoid basal cell carcinoma syndrome) (McNamara & Patel, 2020).

In trauma settings, congenital anomalies such as bifid ribs can be easily misinterpreted as fractures, particularly on standard X-rays or axial CT images, where the division of the rib may mimic a fracture line (Richards et al., 2020). Misinterpretation can lead to unnecessary treatments, including immobilization, pain management focused on fractures, or even surgical consultation, all of which can be avoided with accurate diagnosis. In the case described, the use of 3D CT reconstruction was instrumental in differentiating the bifid rib from a true fracture, preventing mismanagement of the patient (Hounsfield et al., 2019).

The author’s personal experience with three cases of bifid ribs among 350 trauma patients is consistent with the low prevalence of this condition in the general population (Karaman et al, 2020). The lack of structural or functional impact in most cases means that bifid ribs rarely require intervention. However, there are rare instances where the bifid rib may cause compression of intercostal nerves, leading to pain or discomfort. In such cases, surgical intervention may be considered if the patient is symptomatic. Otherwise, no treatment is necessary, and the anomaly can be safely monitored.

CONCLUSION

The use of advanced imaging techniques, such as 3D CT reconstruction, is especially valuable in the evaluation of skeletal anomalies and pathologies. By providing a detailed view of the spatial relationships between bones and soft tissues, these techniques can aid in the accurate diagnosis of conditions that may be missed or misinterpreted on standard imaging (Perez-Garcia et al., 2018). This case highlights the importance of considering congenital anomalies like bifid ribs in the differential diagnosis of chest wall injuries, particularly in the setting of trauma, where accurate differentiation between fracture and deformity is critical for appropriate management (Ribas et al., 2019).

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References

Cheng, Y. F., Chen, S. J., Hsu, W. L., Lee, S. K., & Huang, J. L. (2019). Congenital rib anomalies: Evaluation with multidetector computed tomography. *Insights into Imaging*, *10*(1), 1-12.

Hounsfield, G., Smith, T., & Ramirez, P. (2019). 3D reconstruction in thoracic trauma: A case review. *Radiological Society of North America (RSNA)*.

Karaman, E., Özdemir, M., & Turgut, A. (2020). Incidental rib anomalies in trauma patients: Diagnostic challenges. *Annals of Thoracic Medicine*, *15*(2), 102-108.

McNamara, M. F., & Patel, A. R. (2020). Gorlin syndrome: Radiological findings and clinical presentation. *Radiology Journal*, *35*(4), 205-213.

Ozcanli, E., Kaya, S., & Demir, O. (2021). Chest wall congenital deformities and their clinical significance. *Turkish Journal of Medical Sciences*, *51*(3), 136-145.

Özgür, K., Yildirim, G., & Ersoy, S. (2018). The role of 3D CT in chest trauma. *Journal of Thoracic Imaging*, *33*(2), 120-127.

Perez-Garcia, F., Romero, C., & Martinez, L. (2018). The use of 3D CT in skeletal anomalies: A case series. *Journal of Bone and Joint Imaging*, *15*(1), 45-52.

Ribas, F. A., Andrade, G. S., & Silva, R. D. (2019). Congenital rib deformities in trauma settings: Diagnostic challenges and management. *American Journal of Radiology*, *42*(3), 310-318.

Richards, M. L., Johnson, K. B., & Evans, H. S. (2020). Imaging the chest wall: Anomalies and pathologies. *The Journal of Trauma Imaging*, *40*(1), 22-30.

Silva, V., Santos, A., & Pereira, T. (2017). Bifid rib: A rare cause of rib abnormality. *Journal of Chest Wall Pathologies*, *12*(2), 55-62.

Trauma Imaging: Basic Principles, Elsevier, 2016.

NORTHERN JOURNAL of HEALTH SCIENCES

Case Report

Thyroid Hemiagenesis Co-occurrence with Unilateral Renal Agenesis*

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Abstract

Thyroid Hemiagenesis (THA) is an uncommon congenital disorder characterized by the failure of one thyroid lobe with or without the isthmus to develop. This condition may arise from an abnormal descent or agenesis of the thyroid tissue. Many cases of THA remain asymptomatic and are frequently detected incidentally. This report presents a patient with multinodular goiter, concomitant left-sided thyroid, and renal agenesis. A 40-year-old male presented with a long-standing progressive thyroid enlargement, exhibiting euthyroid status. The patient reported compressive symptoms, including dysphagia, dyspnea, and hoarseness due to the goiter's size. This case report documents the first known case of concurrent THA and Unilateral Renal Agenesis (URA), underscoring the importance of thorough preoperative evaluation for congenital anomalies in THA patients. The absence of the left-sided paired organs in this patient adds to the growing body of literature on the association between these congenital abnormalities.

Keywords: Multinodular Goiter, Thyroid Hemiagenesis, Unilateral Renal Agenesis

INTRODUCTION

Thyroid hemiagenesis (THA) is an uncommon congenital disorder characterized by the failure of one thyroid lobe with or without the isthmus to develop. This condition may arise from an abnormal descent or agenesis of the thyroid tissue. Many cases of THA remain asymptomatic and are frequently detected incidentally. THA is often associated with various thyroid pathologies, such as nodules, de Quervain thyroiditis, hyperthyroidism, thyroid adenomas, Graves'disease, Hashimoto's thyroiditis (Gurleyik & Gurleyik, 2015; Kirdak et al., 2014). It has been reported that genetic abnormalities may play a role in the etiology of THA, as reported in monozygotic twins (Mikosch et al., 2020). Additionally, THA can co-occur with other congenital anomalies, such as renal system abnormalities, mixed connective tissue disease, Down's Syndrome and facial malformations (Lesi et al., 2022). Unilateral renal agenesis (URA) is a congenital absence of one kidney, resulting from the failure of embryonic kidney formation. URA has an incidence of approximately 1 in 2000 live births (Westland et al., 2013). This report presents a patient with multinodular goiter, concomitant left-sided thyroid, and renal agenesis.

Case Report

A 40-year-old male presented with a long-standing progressive thyroid enlargement, exhibiting euthyroid status. The patient reported compressive symptoms, including dysphagia, dyspnea, and hoarseness due to the goiter's size. Physical examination revealed an enlarged right thyroid lobe and isthmus, with a firm, non-tender nodule at the lower pole. The left thyroid lobe was not palpable. Laboratory investigations showed normal levels of free thyroxine (T4: 0.9 ng/dL, normal range: 0.93–1.7 ng/dL), thyroid-stimulating hormone (TSH: 0.86 µIU/mL, normal range: 0.27–4.2 µIU/mL), and parathyroid hormone (PTH: 58 pg/mL, normal range: 15–65 pg/mL).

High-resolution ultrasonography indicated an enlarged right thyroid lobe (40×34×74 mm) with a cystic, degenerative, isoechoic nodule (37×25 mm) at the lower pole. The left thyroid lobe was absent. Fine-needle aspiration biopsy of the dominant nodule in the right lobe revealed non-atypical thyroid cytology. Radionuclide scintigraphy (99mTc pertechnetate) confirmed a hyperplastic right lobe with normoactive heterogeneous nodules in the lower region, while the left lobe was absent (Figure 1).

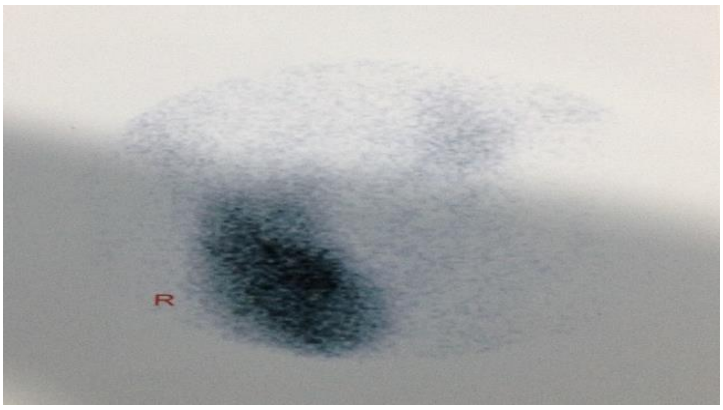

Figure 1. Tc-99m pertechnetate scintigraphy showing the right thyroid lobe and the isthmus. The left lobe was not seen.

Upon reviewing the patient's medical history, it was noted that he had left-sided renal agenesis. Regular urological follow-up had demonstrated normal renal function, as confirmed by abdominopelvic computed tomography (CT) (Figure 2).

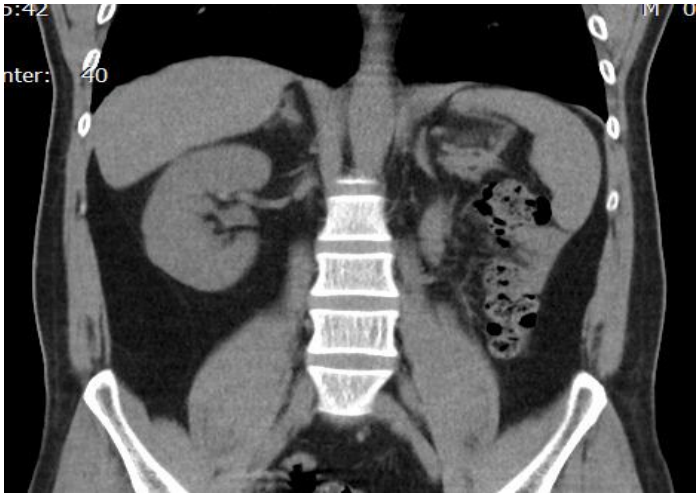

Figure 2. Abdominopelvic CT showing absence of left kidney

No relevant family medical history was reported. Preoperative evaluation suggested multinodular goiter, and surgery was performed. Intraoperatively, the right thyroid lobe and isthmus were found extending to the left of the trachea, and both structures were removed entirely (Figure 3). The patient was discharged on the first postoperative day without complications and started on levothyroxine sodium (0.1 mg). Histopathological analysis confirmed the diagnosis of multinodular adenomatous goiter. The patient's postoperative course was uneventful, and follow-up has been stable.

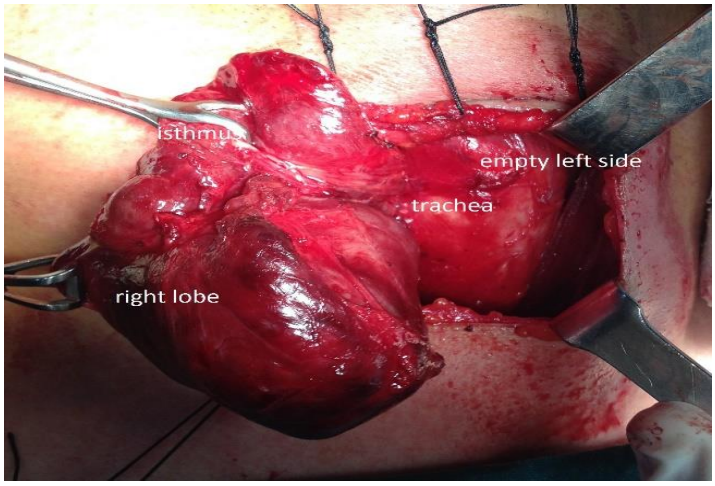

Figure 3. Intraoperative view of the thyroid

DISCUSSION

The embryological development of the thyroid originates from the endoderm of the primitive pharynx. The thyroid primordium migrates to its final anatomical location anterior to the thyroid cartilage and trachea. THA represents the incomplete genesis of one thyroid lobe with or without the isthmus, and the precise etiology remains unclear. It is a rare congenital anomaly, with an estimated prevalence of 0.05–0.2% based on ultrasonographic screening (Lesi et al., 2022; Shabana et al., 2000). Different studies have shown that it usually affects the left lobe with an L:R ratio of 4:1, with 44–50% also lacking the isthmus. The reason for this left-sided predominance remains unknown, though there is a documented propensity for agenesis in paired organs on the left side (7-9). Although our patient was male, THA is more frequently observed in females, a trend that may reflect the higher prevalence of thyroid disorders among women (Mikosch et al., 1999; Melnick &, Stemkowski, 1981; Sereke et al., 2021; Shabana et al., 2000). Ruchala et al. conducted a large cohort study involving 40 patients, which demonstrated a significant female predominance, with a female-to-male ratio of 7:1 (Ruchala et al., 2009).

To date, four genes have been implicated in thyroid development: TTF-1 (Nkx2.1), TTF-2 (FOXE1), Pax8, and the TSH receptor gene (Castanet et al., 2005). While most cases of THA are sporadic, familial clusters have also been reported (Szczepanek et al., 2011). In the literature, THA has been linked to malformations in patients with Pax8 gene mutations (Hermanns et al., 2013). Moreover, experimental studies demonstrate that Pax8 is expressed during the development of both the thyroid and renal systems, underscoring its role as a shared genetic factor in the embryogenesis of these organs (Plachov et al., 1990). Despite extensive review, we could not find any previous cases of URA occurring alongside THA on the same side. Due to limited resources, genetic analysis could not be conducted in this instance. Nevertheless, our patient represents a notable example of concurrent left-sided thyroid and renal agenesis.

Our patient underwent total thyroidectomy for compressive multinodular goiter. Notably, 16% of THA cases are associated with hyperthyroidism, 8% with multinodular goiter, 7% with papillary carcinoma, and 7% with simple goiter (Karabay et al. 2003; Kirdak et al., 2014). Ultrasonography and Tc-99m scintigraphy were critical in diagnosing the absence of the left thyroid lobe. Intraoperative findings confirmed the lack of thyroid tissue on the left side, with no abnormalities in the right parathyroid tissue. Postoperatively, the patient remained asymptomatic, without any evidence of hypocalcemia or hypoparathyroidism.

CONCLUSION

This case report documents the first known case of concurrent THA and URA, underscoring the importance of thorough preoperative evaluation for congenital anomalies in THA patients. The absence of the left-sided paired organs in this patient adds to the growing body of literature on the association between these congenital abnormalities.

Declaration of Interests: The authors have no conflict of interest to declare.

References

Castanet, M., Leenhardt, L., Léger, J., Simon-Carré, A., Lyonnet, S., Pelet, A., Czernichow, P., & Polak, M. (2005). Thyroid hemiagenesis is a rare variant of thyroid dysgenesis with a familial component but without Pax8 mutations in a cohort of 22 cases. Pediatric Research, 57(6), 908-913. https://doi.org/10.1203/01.PDR.0000161409.04177.36

Gurleyik, G., & Gurleyik, E. (2015). Thyroid hemiagenesis associated with hyperthyroidism. Case Reports in Otolaryngology, 2015, 829712. https://doi.org/10.1155/2015/829712

Hermanns, P., Grasberger, H., Cohen, R., Freiberg, C., Dörr, G., Refetoff, S., & Pohlenz, J. (2013). Two cases of thyroid dysgenesis caused by different novel PAX8 mutations in the DNA-binding region: In vitro studies reveal different pathogenic mechanisms. Thyroid, 23(7), 791-796. https://doi.org/10.1089/thy.2012.0141

Karabay, N., Comlekci, A., Canda, M. S., Bayraktar, F., & Degirmenci, B. (2003). Thyroid hemiagenesis with multinodular goiter: A case report and review of the literature. Endocrine Journal, 50(4), 409-413. https://doi.org/10.1507/endocrj.50.409

Kirdak, T., Gulcu, B., & Korun, N. (2014). Thyroid hemiagenesis associated with retrosternal nodular goiter: A case report. Acta Medica Iranica, 52(9), 725-726. PMID: 25325212

Lesi, O. K., Thapar, A., Appaiah, N. N. B., Iqbal, M. R., Kumar, S., Maharaj, D., Saad Abdalla Al-Zawi, A., & Dindyal, S. (2022). Thyroid hemiagenesis: Narrative review and clinical implications. Cureus, 14(2), e22401. https://doi.org/10.7759/cureus.22401

Melnick, J. C., & Stemkowski, P. E. (1981). Thyroid hemiagenesis (hockey stick sign): A review of the world literature and a report of four cases. The Journal of Clinical Endocrinology & Metabolism, 52(2), 247-251. https://doi.org/10.1210/jcem-52-2-247

Mikosch, P., Gallowitsch, H. J., Kresnik, E., et al. (1999). Thyroid hemiagenesis in an endemic goiter area diagnosed by ultrasonography: Report of sixteen patients. Thyroid, 9(11), 1075-1084. https://doi.org/10.1089/thy.1999.9.1075

Mikosch, P., Weixlbaumer, V., Irrgang, M., Aistleitner, A., & Trifina-Mikosch, E. (2020). Hemiagenesis of the thyroid gland detected by coincidence—what is the clinical relevance? Wiener Klinische Wochenschrift, 170, 403-409. https://doi.org/10.1007/s10354-020-00783-w

Plachov, D., Chowdhury, K., Walther, C., Simon, D., Guenet, J. L., & Gruss, P. (1990). Pax8, a murine paired box gene expressed in the developing excretory system and thyroid gland. Development, 110(2), 643-651. https://doi.org/10.1242/dev.110.2.643

Ruchala, M., Szczepanek, E., Szaflarski, W., et al. (2010). Increased risk of thyroid pathology in patients with thyroid hemiagenesis: Results of a large cohort case-control study. European Journal of Endocrinology, 162, 153-160. https://doi.org/10.1530/EJE-09-0590

Sereke, S. G., Oriekot, A., & Bongomin, F. (2021). Thyroid hemiagenesis with a TI-RADS 2 nodule in the contralateral lobe. Thyroid Research, 14, 10. https://doi.org/10.1186/s13044-021-00101-5

Shabana, W., Delange, F., Freson, M., Osteaux, M., & De Schepper, J. (2000). Prevalence of thyroid hemiagenesis: Ultrasound screening in normal children. European Journal of Pediatrics, 159, 456-458. https://doi.org/10.1007/s004310051307

Szczepanek, E., Ruchala, M., Szaflarski, W., et al. (2011). FOXE1 polyalanine tract length polymorphism in patients with thyroid hemiagenesis and subjects with normal thyroid. Hormone Research in Paediatrics, 75, 329-334. https://doi.org/10.1159/000322874

Westland, R., Schreuder, M. F., Ket, J. C., & van Wijk, J. A. (2013). Unilateral renal agenesis: A systematic review on associated anomalies and renal injury. Nephrology Dialysis Transplantation, 28(7), 1844-1855. https://doi.org/10.1093/ndt/gft012